D R A F T F OR EXTERNAL REVIEW
November 30, 2006

CBRN SCBA User's Guide:

Technical Use of NIOSH-Certified Open-Circuit, Pressure-Demand, Self-Contained Breathing Apparatus (SCBA) Respirators with Chemical, Biological, Radiological, and Nuclear (CBRN) Protections Certified Under Title 42, Code of Federal Regulations, Part 84

(OD Review # 04031)

United States Department of Health and Human Services
Centers for Disease Control and Prevention and Agency for Toxic Substances and Disease Registry
National Institute for Occupational Safety and Health
National Personal Protective Equipment Technology Laboratory

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Front cover description: Depicts two distinct CBRN SCBA commonly used by emergency responders. They both use mask mounted regulators detached or integrated on the SCBA. The schematic on the left is a detachable mask mounted regulator (MMR). The one on the right is a non-detachable, or integrated, air hatch/switch mask mounted regulator (MMR) SCBA. Drawings are designed by Mr. Marion Molchen, KI, LLC, for NIOSH and adapted from respirators manufactured by Mine Safety Appliances Company (MSA) and International Safety Instruments, Inc. (ISI), August 17, 2006.

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FOREWORD

"Terrorists have declared their intention to acquire and use weapons of mass destruction (WMD) to inflict even more catastrophic attacks against the United States, our allies, partners, and other interests around the world." *National Strategy for Combating Terrorism,* The Whitehouse, September, 2006.

The national strategy for combating terrorism states that perpetrators have declared their intentions to use systematic violence, terror, and intimidation through the use of weapons of mass destruction. NIOSH has created and validated scientific methods to ensure emergency responders have certified respirators to protect themselves against the potential terrorist intentions. A NIOSH-certified SCBA with chemical, biological, radiological, and nuclear (CBRN) protections provides the highest level of respiratory protection against the terrorism respiratory hazards expected from rudimentary CBRN agents or toxic industrial chemicals.

In addition to the WMD terrorism threat, safety and health hazards from natural disasters, structural fires, and industrial accidents continue to pose unique challenges to emergency responders. Natural disasters have created workplaces requiring dynamic job site analysis and safety measures: workplaces such as public civilian evacuation by helicopter, mass evacuee sheltering, and civilian home aftermath recovery. The safety measures that are vital to protecting responders and other workers in these occupational challenges, have proven themselves effective and continue to evolve. These same safety measures are being updated for emergencies involving pandemic influenza and known chemical, biological, radiological, and nuclear weapons effects. All of these workplaces require dual-use personal protective equipment (PPE). PPE that can be effectively used by multiple emergency response disciplines without logistical redundancy. The NIOSH-certified respirators with CBRN protections are such dual-use devices.

Producing NIOSH respirator CBRN performance standards and certifying respirators is vital, but knowledge of the respirator's limitations and proper use of the respirator are also critical, and in fact, are considered to be lynchpin actions for survival. When properly trained, an emergency responder can rely on NIOSH user guidelines to provide a host of best practices and recommendations. To generate the user guidelines for a CBRN incident, NIOSH deferred to experienced chemical warfare military officers and government civilians, qualified industrial scientists and engineers, and public information gained from users that rely on NIOSH-certified respirators for everyday protection. The *NIOSH CBRN SCBA User's Guide and Training Aid* is one such guideline. It provides best practice recommendations to emergency responders and respiratory program managers on how to use a CBRN SCBA. Key points show a responder how to recognize federal labels for new or retrofitted NIOSH-certified SCBA with CBRN protections, how to translate the NIOSH cautions and limitations for practical use, and how to best use a CBRN SCBA before, during, and after an incident.

The NIOSH has been formally documenting and evaluating SCBA for CBRN protections, since October 17, 2001. And as you know, the first NIOSH-certified SCBA with CBRN protections approval was issued on May 31, 2002. This could not have been done without the total support of aligned federal agencies and stakeholder requests. This CBRN SCBA user's guide is in response to those same requests. Therefore, it is with great honor and pride that I offer the first CBRN respirator use guideline to the emergency responders of America.

Director's Signature Block

ACKNOWLEDGMENTS

(To Be Published)

DEFINITIONS

1. Agent – A terrorist grade or military grade chemical, biological, or radiological contaminant that causes change or effects on an exposed material substrate or human tissue.

2. Acute Exposure Guideline Levels (AEGLs) – Published by the National Research Council/National Academy of Science (NAS) and the U.S. Environmental Protection Agency, acute exposures are defined as single, non-repetitive exposures for not more than eight hours. Based on that definition, acute exposure guideline levels characterize the risk to the general population during a one-time accident or emergency scenario. The values are measured in mg/m3 and represent threshold exposure limits for the general public. They are applicable to emergency exposure periods ranging from 10-minutes, 30-minutes, 60-minutes, 4-hours, or 8- hours and are categorized by levels known as AEGL-1, AEGL-2, and AEGL-3. AEGL are used by NIOSH for CBRN SCBA breathing zone performance pass/fail criteria. For additional information go to http://www.epa.gov/oppt/aegl/pubs/results31.htm

3. CASARM Grade Agent– U.S. Army Chemical Agent Standard Analytical Reference Material (CASARM) grade agent. It is a chemical warfare agent purity standard required by NIOSH for certification of respirator performance against GB and HD concentrations in accordance with NIOSH CBRN special test requirements. A CASARM grade certification of purity is as follows: *CASARM grade Sarin (GB) (Lot # GB-U-6814-CTF-N) had a certified purity of 98.7 +/- 1.9 wt % of GB as determined by acid-base titration.* Impurity % of the CASARM grade agent can be based on mole ratios from acid-base titration or other equivalent methods.

4. CBRN – A NIOSH-approved *type* of protection, as opposed to a *level* of protection. CBRN stands for Chemical, Biological, Radiological and Nuclear (CBRN) and refers to the NIOSH recognized level of respiratory protection afforded by a certified respirator system against a specific type or types of vapor, aerosol, liquid, or particulate contaminants at laboratory generated concentrations. It is a four letter acronym that is required to be listed on the NIOSH label for a CBRN SCBA and to be in the TC 13F- approval number sequence of that same CBRN SCBA. The explosive energy effects from a nuclear detonation or conventional explosion are not deterred by donning and wearing a NIOSH-certified respirator with CBRN protections.

5. CBRN SCBA – A NIOSH-Certified Open Circuit, Pressure-Demand, Entry and Escape SCBA with CBRN protections –The CBRN SCBA are atmosphere-supplying respirators with an integral breathing air source/cylinder designed to be carried by the user. The CBRN SCBA rely on a full-face tight fitting facepiece tethered to an air source for protecting the breathing zone/oral nasal, ocular, and facial regions of the user. The CBRN SCBA is required to display the NIOSH *CBRN Agent Approved* or *CBRN Agent Approved (Retrofit)* adhesive label on the back frame in addition to the NIOSH traditional harness label and NFPA 1981 compliance label.

6. Chemical Warfare Agents (CWA) – CWA are toxic chemical compounds, usually man made and specifically intended for military warfare operations to kill, seriously injure, or incapacitate people. CWA or their precursors, when used by groups or individuals for terrorism objectives, pose a significant danger to emergency responders. NIOSH cautions and limitations "*T*" and "*U*" for the CBRN SCBA were created based on the laboratory observations of respirators contaminated with CWA identified in the U.S. Army, Marine Corps, Navy, and Air Force Field Manual 3-11.9, dated January, 2005.The CWA specifically are the

nerve agents (GB (Sarin), GA (Tabun), GD (Soman), GF and VX) and the blister agents (H (sulfur mustard), HD (distilled sulfur mustard), nitrogen mustard (HN-1, HN-2 and HN-3) and Lewisite (L, L-1, L-2 and L-3)).

7. Contaminated – An adjective that describes the known or suspected condition of an item of personal protective equipment, as a result of contact with a CBRN agent. It is understood that it has been or is in contact with the liquid, vapor, aerosol, and/or particulate physical states of chemical, biological, radiological or nuclear agents or byproducts of CBRN agents, via contact processes such as deposition, absorption, or adsorption.

8. CBRN Approved – A NIOSH common phrase meaning an item of personal protective equipment has been evaluated, reviewed, and certified by NIOSH to provide a specific type of protection against chemical, biological, radiological, and nuclear contaminants by using the laboratory concentrations of CASARM grade chemical warfare agents GB, HD, and a FDA approved Corn Oil particulate. CBRN Approved SCBA rely on special tests that use GB, HD, and Corn Oil for certification while CBRN APR use GB, HD, Corn Oil and 11 Test Representative Agents (TRA)/Toxic Industrial Chemicals for certification. An approval letter awarding CBRN protection certification is issued to an approval holder based on the provisions of 42 Code of Federal Regulation, Part 84 (42CFR84) and the applicable NIOSH CBRN respirator statement of standard. In the case of the CBRN SCBA, the approval process utilizes a three tiered sequence for testing and validating the awarded CBRN protection.

9. Decontamination – A simplified or complex process intended to make PPE safe for continued use, limited re-use or disposal by decreasing the amount of contamination on an object or area through the actions of absorption, neutralization, detoxification, destruction, aeration/ventilation, or physical removal of known or suspected contamination. Compounds that are used for decontamination are known as decontamination agents. A decontamination agent standard per type of CBRN agent is required that specifies criteria for how-clean is clean.

10. Event of National Significance— Major event, as determined by the President of the United States, that is vulnerable to terrorism and other criminal acts.

11. Exposure – The act or instance of exposing the internal physiology of a living organism to a contaminant that has acute or chronic effects on the subject i. e. CBRN exposure. Being contaminated does not necessarily mean a subject is exposed. The protective qualities of the worn personal protective equipment can be contaminated but the wearer may not be exposed until the PPE is compromised as a result of being subject to some detrimental effect or harmful condition such as CBRN contamination.

12. Emergency Responder/Emergency Response Provider – An emergency responder or emergency response provider that includes federal, state, local, and tribal emergency public safety, law enforcement, emergency response, emergency medical, including hospital emergency facilities, and related personnel, agencies, and authorities. (DHS)

13. First Responder – Local and non-governmental police, fire and emergency personnel who, in the early stages of an incident, are responsible for the protection and preservation of life, property, evidence, and the environment, including emergency response providers as defined in Section 2 of the Homeland Security Act of 2002, as well as emergency management, public health, clinical care, public works, and other skilled

support personnel, such as equipment operators, who provide immediate support services during prevention, response, and recovery operations. First responders may include personnel from federal, state, local, tribal or non-governmental organizations.

14. Fit Factor – A numeric value that is product of the quantitative measure of how effectively a specific respirator facepiece seals to a specific individual's face or head region. CBRN respirator testing relies on the generation of Laboratory Respirator Protection Level (LRPL) quantitative fit factor measurements to confirm sizes of specific respirators fit a range of human test subjects. Fit factors are determined by recognized fit testing technology that determines the ratio values of the concentration of a non-toxic substance in ambient air outside the respirator against the determined concentration inside the respirator while the respirator is self donned and undergoing a series of exercises by a human test subject.

15. Fit Test – Confirm definition from page 30, (3). NIOSH Respirator Selection Logic, 2004, defines it as "The use of a specific measurement protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual." Qualitative fit test (QLFT) or quantitative fit test (QNFT) are examples of fit tests. Fit tests utilize user seal checks in the conduct of a fit test to confirm the facepiece is sealing. User seal checks are not considered fit tests by NIOSH because they are strictly pre-use techniques that a user does to qualitatively confirm that the respirator is donned correctly.

16. Immediately Dangerous to Life or Health (IDLH) – Conditions that pose an immediate threat to life or health or conditions that pose an immediate threat of severe exposure to contaminants, such as radioactive materials, which are likely to have adverse cumulative or delayed effects on health.

17. Laboratory Respirator Protective Level (LRPL) Test – A NIOSH-approved CBRN respirator certification test that uses human test subjects to ensure the facepiece seal interface between the test subject and the respirator performs to an established protection level in a quantified laboratory chamber containing a specific amount of corn-oil or equivalent aerosol particulates. A CBRN SCBA LRPL test trial is conducted using 11 exercise movements on human test subjects, which closely approximates the facial shapes and sizes of the user population at the 95th percentile based on a Los Alamos National Laboratory (LANL) panel of facial sizes.

18. Live Agent Test (LAT) – Common term used to describe a NIOSH special CBRN respirator certification test that measures CWA permeation and penetration resistance qualities of a respirator contaminated by actual or "live" Sarin (GB) vapor/aerosol or sulfur mustard (HD) liquids, vapors, and aerosol. The acronyms *GB LAT* or *HD LAT* describe a specific phase of NIOSH testing the respirator is in or has completed.

19. National Personal Protective Technology Laboratory (NPPTL) – A laboratory of the National Institute for Occupational Safety and Health (NIOSH). NPPTL operates the national certification program for civilian respirators used in all types of workplace environments, which includes CBRN protected respirators.

20. NFPA 1981 Standard – Standard on Open Circuit Self-Contained Breathing Apparatus for Firefighters and Emergency Services Personnel. Updated every 5 years, currently it is part of the second tier of approval for the CBRN SCBA. The NFPA 1981 edition in effect, at the time of the NIOSH CBRN approval letter, is the edition under which the CBRN SCBA must demonstrate NFPA code compliance.

21. NIOSH-Approved – It is a term that describes a respirator system and its accessory components that have been reviewed and certified by NIOSH in accordance with 42 CFR Part 84 and determined approved for use by the workers in defined workplaces. Approval authority is derived by 42 CFR Part 84 to provide coverage for industry and, therefore, issued approvals are in support of OSHA. To determine CBRN certification in a NIOSH-approved respirator specific labels and TC-approval numbers must exist and be on NIOSH record.

22. Oxygen Deficient Atmosphere – An atmosphere which contains an oxygen partial pressure of less than 148 millimeters of mercury (19.5 percent by volume at sea level).

23. Nuclear Agents – Radiological contaminated particulates resultant from the detonation of an improvised nuclear device (IND), high yield, or low yield nuclear weapon detonation. The blast effects or electromagnetic pulse effects from nuclear weapons detonations are not considered in the definition of nuclear agents for the acronym CBRN.

24. Penetration – The act or process of penetrating, piercing, or entering. One of two dominate physical science processes that bypass existing protective material surfaces and contaminate air pressure boundaries or material interfaces of a candidate CBRN respirator.

25. Permeation – The action of passing through the openings of a substrate at the surface level or the molecular level. One of two dominate physical science process that bypass existing protective materials or air pressure boundaries and contaminate the breathing zone, which, if worn by a user would expose the user to toxic agents. If the agent permeates under laboratory ideal conditions, most likely it will permeate under confined space or enclosed space hazardous conditions.

26. Personal Protective Equipment (PPE) – Clothing and equipment used to shield or isolate individuals from the chemical, physical, and biological hazards that may be encountered at a hazardous waste-site. PPE should protect the respiratory system, skin, eyes, face, hands, feet, head, body, and ears.

27. Positive Pressure Respirator – A respirator in which the pressure inside the respiratory inlet covering exceeds the ambient air pressure outside the respirator.

28. Protective Suit Ensemble – The complete personal protective equipment outfit (i.e., respirator, gloves, boots, clothing, etc., required for an event or task.

29. Radiological Agents – Particulate-borne radiation dispersed by detonation of a radiological dispersive device (RDD) or "dirty bomb."

30. Rapid Intervention Crew /company Universal Air Connection System (RIC UAC) – A portable compressed air system consisting of compatible interfaces that allows emergency replenishment of breathing air to the SCBA for down, disabled, or entrapped emergency responders.

31. Rated Service Time – A manufacturer assigned value or a NIOSH-approved time of duration value assigned to a SCBA based on breathable air consumption at a moderate work rate.

32. Respiratory Protection Program – A written procedure used to ensure that respirators are properly selected, used, and maintained by identified personnel. The program is to be administered by a suitably trained administrator and the program elements must meet the criteria specified in the OSHA respiratory protection standard (29 CFR 1910.134).

33. Terrorism – Per the Department of Homeland Security National Response Plan, it is any activity that (1) involves an act that (a) is dangerous to human life or potentially destructive of critical infrastructure or key resources; and (b) is a violation of the criminal laws of the United States or of any State or other subdivision of the United States; and (2) appears to be intended (a) to intimidate or coerce a civilian population; (b) to influence the policy of a government by intimidation or coercion; or (c) to affect the conduct of a government by mass destruction, assassination or kidnapping.

34. Toxic Industrial Chemicals (TICs) – a variety of chemicals used in various routine industrial processes which can, if inadvertently or deliberately released, possibly kill, seriously injure, or incapacitate people, flora, or fauna.

35. User/User's instructions (UI) – A NIOSH recognized manufacturer publication required to be submitted to NIOSH as part of a certification application requesting NIOSH approval. The UI are included with every new purchase of a NIOSH approved respirator.

36. User Seal Check - An action conducted by the respirator user to determine if the respirator is properly seated to the face to create a viable face-to-facepiece seal as determined by the unique physical parameters of the user's face, and other areas such as the neck or head as applicable and the unique engineered designed respirator sealing surfaces of any given respirator.

37. CBRN Respirator Use Life (CRUL) – A unique respirator in-use time value identified in a NIOSH caution and limitation (s) designed to provide the highest level of respiratory protection to the breathing zone of individual emergency response workers wearing serviceable and fit tested CBRN respirators. The CRUL value is a mandatory maximum in-use time a specific type of CBRN respirator can be safely used after being potentially or actually contaminated with aerosolized or liquid chemical warfare agents.

38. Weapon of Mass Destruction - As defined by Title 18, U.S.C. 2332a: (1) Any explosive, incendiary, or poison gas, bomb, grenade, rocket (having a propellant charge of more than 4 ounces), missile, mine, or similar device (having an explosive or incendiary charge of more than one-quarter ounce); (2) Any weapon that is designed or intended to cause death or serious bodily injury through the release, dissemination, or impact of toxic or poisonous chemicals or their precursors; (3) Any weapon involving a disease organism; or (4) Any weapon that is designed to release radiation or radioactivity at a level dangerous to human life. Per select information from paragraphs (1) to (4) above, CBRN agents are weapons of mass destruction.

Chapter 1: RESPIRATOR STANDARD DEVELOPMENT, RATIONALE, USE FEATURES and PROTECTIONS

1-A. PURPOSE

The purpose of the guide is threefold. First, the guide is intended to assist respirator users, respirator program administrators and response supervisors in how to recognize NIOSH-approved CBRN SCBA. Second, the guide is intended to educate users on the applicable cautions and limitations of a CBRN SCBA so they know that the CBRN SCBA will not be the all encompassing "magic respirator". And third, it provides NIOSH recommended user guidelines and best practices for protecting emergency responders responsible for conducting life-saving actions before, during, or after a CBRN event.

NOTE: When properly used, NIOSH-certified SCBA with CBRN protections will protect you against field and confined space respiratory concentrations of CBRN agents. Situation dependent, the CBRN SCBA must be used in conjunction with appropriate full body protective ensembles. Expedient coverage of all exposed skin will help reduce the amount of CBRN agent a first responder is contaminated with or exposed to and ultimately the severity of potentially debilitating acute or chronic effects, if that coverage is used in time. Proper use of a CBRN respirator is a complex process requiring the knowledge of proper selection and fit of a respirator for a specific respiratory contaminant, sampling and monitoring data to characterize a work environment, and refresher training on respirator use limitations prior to entry. The sole use of a CBRN SCBA with fire fighter protective ensemble/bunker gear or other mission specific duty uniforms will not protect you from the effects of all or some CBRN agents. You must wear CBRN SCBA with appropriate protective ensembles for all unknown hazardous entries, stays, and escapes and where weapons of mass destruction have generated potential or confirmed CBRN hazards.

INTENT: The guide provides recommended actions for clearly identifying newly purchased CBRN SCBA, inspecting field deployed SCBA upgraded to CBRN protection (retrofitted), and developing use life criteria for contaminated CBRN SCBA. It also provides recommendations for inspecting SCBA for NIOSH CBRN compliance, distinguishing between NIOSH CBRN approved SCBA and NIOSH industrial approved SCBA or NFPA compliant SCBA, preparing respirators for CBRN response, using respirators in potential or known CBRN incidents and discarding contaminated respirators in post-incident responses.

STANDARDIZATION OF TERMS: Certain portions of the guide are useful in daily operations for respirator protection program administrators; however, most of the information is focused on how to assist emergency responders in identifying, maintaining, using, and integrating CBRN SCBA. In the course of assisting responders in those tasks, standardization of terms will occur and contribute to more efficient emergency operations. One example of multiple terms for the same type of equipment is the fact that some responders use the name "SCBA" for the open-circuit SCBA, while others use "BA", or "Air Paks" when referring to a SCBA or confuse the types of respirators between open circuit SCBA, gas masks (APR), and closed circuit SCBA. A SCBA is a respirator per 42CFR Part 84.

OSHA IMPACT: The information in this guide is intended to be administered under the Occupational Safety and Health Administration (OSHA) Respiratory Protection Standard and relies on the user being properly trained and proficient [29 CFR 1910.134].

Information on the OSHA Respiratory Protection Standard [29 CFR 1910.134] is available at: http://www.osha.gov/SLTC/etools/respiratory/index.html

GUIDE DYNAMICS: The CBRN SCBA user's guide is subject to continual review and update as facts and best practices change due to technology evolutions, standards development, or changes in incident response protocol due to world events or aftermaths. While the guide is intended for respirator users, as stated, it contains elements that are ideally suited for consideration by respirator protection program administrators, supervisors, and incident commanders.

SITUATIONAL ANALYSIS: How a respirator program administrator or incident commander integrates the use of CBRN SCBA is contingent on the recognition and adaptation of available respirator selection logic and incident situational analysis at the time of respirator selection use.

1-B. Collaborative Efforts in CBRN Respirator Standards Development

1-B-1. The Inter Agency Board (IAB). In October 1998, the Attorney General of the United States and the Department of Defense's Director of Military Support commissioned a first responder "interagency board". The board, which became known formally as the InterAgency Board for Equipment Standardization and InterOperability Working Group (IAB), is supported by voluntary participation of various local, state, and federal government and private organizations. The IAB mission is to establish and coordinate local, state and federal standardization, interoperability, and responder safety, and to mitigate and recover from any incident by identifying requirements for chemical, biological, radiological, nuclear or explosives (CBRNE) incident response equipment [IAB 1999].

IAB MISSION: The IAB accomplishes its mission statement by using committee consensus results and subgroup analysis techniques to generate generic equipment and CBRNE reference lists in twelve sections: PPE, explosive device mitigation and remediation equipment, CBRNE operational and search and rescue equipment, information technology, cyber-security enhancement equipment, interoperable communications equipment, detection, decontamination, medical, power (electrical), CBRNE reference materials and CBRNE standards [IAB 1999].

JOINT MOU: In 1999, the IAB initiated a request for the development of federal standards and guidelines for personnel protective equipment, with respiratory protection equipment as one of the top priorities. In response to this 1999 initiative, the National Institute for Standards and Technology (NIST), the National Fire Protection Association (NFPA), NIOSH, and OSHA entered into a memorandum of understanding that defines each agency's role in developing, establishing, and enforcing standards or publishing guidelines for responder respiratory protective devices. Since the inception of the IAB, annual reports, standardized equipment lists and user interface to a "Responder Knowledge Base/RKB" have been published. The most recent report and access to the RKB are at http://www.iab.gov .

1-B-2. Inter-Agency Agreement (IAA). In 2001, the Centers for Disease Control and Prevention (CDC) and NIOSH entered into an inter-agency agreement with the United States Army, Soldier, Biological, Chemical Command (SBCCOM/RDECOM) titled *Testing Activities to Support Respirator Standards Development and Approval Testing (IAA 02-03).* The IAA allowed multiple federal agreements between the signature parties. The following extracts of the IAA define the agreements reached for consensus work: 1.) NIOSH plans to collaborate with RDECOM on the establishment of test procedures for various classes of respirators for use by first responders to incidents of terrorism 2.) NIOSH provides RDECOM standard test procedures 3.) NIOSH reimburses RDECOM for costs of conducting NIOSH laboratory tests. In return: 1.) RDECOM provides laboratory testing and administrative services for performance of NIOSH standard test procedures requested by NIOSH/NPPTL 2.) RDECOM assures that its laboratory practices are documented and followed 3.)RDECOM provides NIOSH with test reports for all required tests 4.) RDECOM collaborates with NIOSH on the establishment of new test procedures for various classes of respirators used by first responders to incidents of terrorism [CDC 2001]. The collaborative standards development and research efforts of IAA 02-03 resulted in the publication of the first NIOSH CBRN SCBA certification standard, dated December 28, 2001. This resulted in the ongoing CBRN SCBA certification program and CBRN SCBA upgrade kit/retrofit certification program, as well as serving as a launch point for follow on CBRN standards applicable to other categories of NIOSH-approved respirators. Information related to the CBRN SCBA standard and CBRN SCBA upgrade/retrofit kit letter is located at the following websites: http://www.cdc.gov/niosh/npptl/standardsdev/cbrn/scba/ http://www.cdc.gov/niosh/npptl/resources/pressrel/letters/lttr-031103c.html

1-B-3. The National Institute for Occupational Safety and Health (NIOSH) and the National Personal Protective Technology Laboratory (NPPTL). Established in 2002, the NIOSH National Personal Protective Technology Laboratory leads the development of civilian CBRN respirator certification program and research that contributes to U.S. emergency responder preparedness. Working with diverse business and federal partners, NPPTL expedited development and publication of stringent new testing and certification respirator standards for voluntary use by emergency responders in CBRN terrorist attacks. NIOSH fast tracked a exploratory SCBA benchmark testing, and established this new program to meet the understood emerging needs of emergency responders in the post 9-11 era.

To determine the testing and certification requirements for the CBRN SCBA, the following areas were defined, reviewed, and acted on by NPPTL and NIOSH.

- Bench mark testing of current SCBA technology was conducted by NIOSH, with the support of the International Safety Equipment Association (ISEA), in October, 2001. The survey allowed NIOSH to conduct exploratory testing on available NIOSH-approved, European (EN) approved, U.S. military specified (Mil-Spec), and NFPA-compliant SCBA currently available to emergency responders in the United States. NIOSH used existing U.S. Army chemical warfare agent test methods and adapted them for NIOSH bench mark exploratory testing purposes.

- Parallel to the SCBA benchmark testing, a NIOSH team reviewed the applicability of current industrial respirator certification standards and the NIOSH authority to implement new CBRN SCBA certification testing by policy, as opposed to formal rule-making changes to the current 42 Code of Federal Regulations, Part 84.

- A hazard analysis, of chemical warfare agent (CWA) use venues in multiple open-air situations or confined spaces was defined by the U.S Army RDECOM and the NIOSH, and adopted by NIOSH/NPPTL. Because chemical gas and vapors are considered more reactive than radiological and biological particles, the focus of SCBA CBRN testing is on chemical warfare agent vapor, aerosol, and liquid penetration and permeation effects.

- A corresponding NIOSH and RDECOM analysis of human factor and CBRN special test requirements was written and validated under the IAA. The new NIOSH CBRN SCBA standard test procedures (STP) were published using the public comment process and implemented by existing policy. The following Table 1 and Tabel 2, entitled *GB (Sarin)Agent Data and HD (Mustard) Agent Data - Time versus Concentration*, are samples of benchmark test result graphs produced from the NIOSH-SBCCOM benchmark survey. A discussion regarding those observations was conducted with respirator manufacturers in 2001. NIOSH provided each respirator manufacturer that attended the discussion with their own proprietary binder of the test results identical to Tables 1 and 2 but specific to their SCBA tested. Table 1, GB, shows the SCBA nose-cup data. Table 2, HD, is nose-cup data as well, but with a color code key showing nine data trails for the nine SCBA HD trials. More detailed information, minus the proprietary raw data, is summarized in working observations and attached as a separate appendix to this guide.

- The observations are exploratory repeatable laboratory results and served to provide bench mark reference and standard test procedure foundations for NIOSH CBRN SCBA standards development. They were not intended to be used as final interpretations of SCBA performance but simply as assessments of the test methodologies available to generate "neat" agent concentrations against available civilian respirators mounted on a breathing mechanical head forms. Dramatic observations, such as catastrophic destruction of a Mustard (HD) contaminated second stage regulator and a Sarin (GB) rapid penetration of the SMARTMAN breathing zones of SCBA, provided NIOSH with scientific evidence sufficient enough to commence development and publication of a new STP.

(Insert appropriate SMARTMAN illustration here)

Table 1: *GB (Sarin) Agent Data - Time Versus Concentration* – NIOSH-approved/EN-approved SCBA, nine inputs on a 480 minute y-axis, October 18-30, 2001.

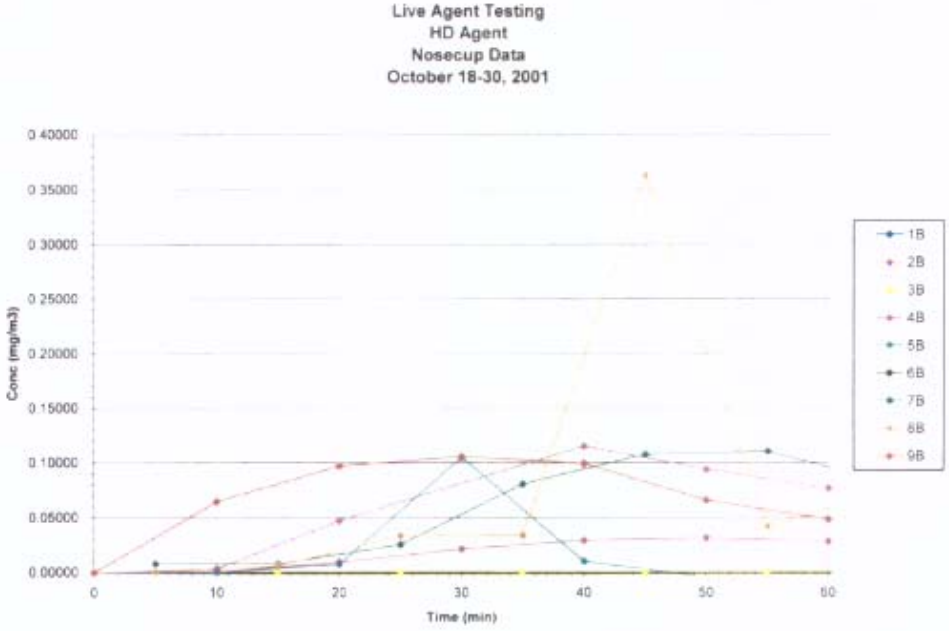


Table 2: *HD (Mustard) Agent Data -Time Versus Concentration* – NIOSH-approved/EN-approved SCBA, coded 1B-9B on a 60 minute y-axis, October 18-30, 2001.

The NIOSH/NPPTL and RDECOM hazard analysis considered the physical constant characteristics of chemical warfare agents and the use of target modeling techniques to generate contamination concentration profiles for the potential hazards of an incident involving different containers of CWA. For these assessments, the means of delivery and dissemination of the CWA were considered,

combined with other variables, including the amount of CWA employed, and the environmental and physical characteristics of the area where the incident may occur. This threat analysis and the inclusion of U.S. Environmental Protection Agency (EPA) toxicological acute exposure guideline level (AEGL) values were incorporated into CBRN SCBA special test requirements, as well as, resultant pass/fail values from STP validation.

Consequently, a NIOSH-certified SCBA with CBRN protections has a triple level of compliance review. It starts with a 42 CFR Part 84 TC-13F review followed by NFPA 1981 standard compliance review, and then a NIOSH special CBRN test assessment and review. The result is a respiratory protective device that provides a higher degree of inhalation protection againstall hazards while adapting to currently available technology. The adoption of the triple level of review has become known as the "Three-Tier Approval Process."

1-C. Three Tiers of Approval: NIOSH, NFPA, and Special CBRN Requirements.

NIOSH established the three-tier approval program in conjunction with NFPA and the U.S. Army. It is intended to enhance performance and design requirements for certification, to meet identified respiratory protection needs specified by respirator manufacturers, to support environmental use conditions of emergency responders, and to prevent emergency responder hazard exposures from variable scenarios ranging from open air to confined space venues. The worst case scenario was determined to be a confined space venue with the possibility of concentrated chemical warfare compounds, lower explosive limits (LEL), varying oxygen levels, or displaced oxygen concentrations.

1-C-1. Tier Descriptions

- **Tier 1** — Tier 1 is the traditional NIOSH industrial certification requirement for an SCBA. The first tier ensures the CBRN SCBA meets existing NIOSH industrial 13F minimum SCBA performance requirements to Subpart H of 42 CFR Part 84. The SCBA CBRN certification program utilizes the vast amount of experience NIOSH has in approving industrial technical certification number (TC-) 13F approvals in the occupational workplace under 42CFR84, subpart H, as well as subpart L. The CBRN SCBA candidate is required to obtain NIOSH 13F approval prior to being submitted for NIOSH CBRN protection testing.

- **Tier 2** — Tier 2 is the NFPA compliance certification and review by the designated NFPA organization for NIOSH. It is done by an independent, third party accredited certification organization to the *NFPA 1981, Standard on Open-Circuit Self-Contained Breathing Apparatus for Emergency Services, current edition*. The NFPA 1981 standard contains critical SCBA performance requirements unique to firefighting and operations in hazardous environments [NFPA 1981]. Compliance with *NFPA 1981* ensures the CBRN SCBA can withstand routine structural fire hazard exposure —a protective quality deemed necessary in responding to any aftermath of an explosive terrorist device. NFPA compliance testing for the program incorporates the enhanced performance requirements of the *NFPA 1981* standard including higher minimum flow rates and improved breathing resistance. *NFPA 1981* testing simulates SCBA use conditions through environmental exposures including high and low temperature conditions, heat and flame exposure, accelerated corrosion, particulate exposure, and vibration. Lens abrasion and

communications (i.e., speech intelligibility while wearing the SCBA) also are evaluated. The NIOSH CBRN SCBA program benefits from other standards development organizations by adapting existing standards where applicable and thus utilizes the best of available respirator technology.

- **Tier 3** — Tier 3 is the NIOSH special CBRN test requirements. It consists of three CBRN special tests:
  - 1) Sarin/GB Live Agent Test (LAT)
  - 2) Distilled Sulfur Mustard/HD LAT
  - 3) Laboratory Respirator Protection Level Test (LRPL) with Corn Oil.

    - **LAT**: LAT measure CWA permeation and penetration resistance against Sarin vapor-aerosol (GB) and sulfur mustard (HD) liquid and aerosol. These compounds are actual chemical warfare agents of neat grade in a CASARM program. They are commonly known as "live agent(s)", as opposed to simulated agent or training agents, and they are used to gain assessment of the respirator's protective qualities against the unique penetration properties of GB liquid aerosol and the caustic permeation properties of HD liquid aerosol and HD liquid droplets.

    - **SYSTEMS FOCUS:** GB and HD LAT involve contaminating the entire SCBA system, to include the neck cylinder valve and assembly, to chemical warfare agents while mounted on a breathing metal headform. LAT generally require two phases of deliberate testing: the pre-screening particulate assessment and the chemical warfare agent contamination test. In the pre-screening particulate assessment a calibrated instrument called a TDA-99M uses non-toxic oil aerosol to check for gross air pressure boundary leaks before the live agent test is conducted. Following the initial "before" test pre-screening, a SiMulant Agent Resistant Test Manikin (SMARTMAN) head form is used to replicate a consistent headform shape to mount and breath the respirator on. In the live agent test chamber, another TDA-99M procedure is done to verify sealing and confirm that air pressure boundaries are intact prior to agent release. The CWA Sarin (GB) and Distilled Sulfur Mustard (HD) are then used to evaluate the CBRN SCBA protection of the breathing zone of a static manikin head form while the respirator breathes at a cyclic rate for six continuous hours. The resultant resistance of the SCBA systems and accessories to agent penetration and permeation is detected by dual redundant instruments under controlled A2L2 International Standards Organization (ISO) compliant laboratory conditions.

    - **LRPL LINK:** The laboratory respirator protection level (LRPL) test determines the degree of fit a given respirator faceblank allows and whether or not that faceblank and the size range marketed by the manufacturer, can fit a wide range of facial sizes based on the accepted Los Alamos National Laboratory (LANL) distribution of face size panel. The LRPL test trials ensure that the seal of the breathing zone quantitatively demonstrates an acceptable fit factor ratio of greater than 500 on human test subjects. The human test subjects are managed in accordance with a human subject review board (HSRB) protocol and the face size distribution panel is intended to approximate 95% of the facial sizes of a given user population, at the time of data generation.

1-D. RATIONALE, USE FEATURES and PROTECTIONS

1.D-1. RATIONALE

A certainty during a terrorist event is the unpredictability of the type, magnitude, and duration of the hazard. In explosions, fire hazards are often, if not always, present. Whether a CBRN agent is dispersed in an improvised explosive device (IED), a Ziploc bag, a propane tank, a strategic military weapon, a terrorist technical dispersion device (TTDD) or a chlorine tanker vehicle-borne IED, one of the most important protections is a fire hazard protection, followed by a chemical warfare agent protection. Take the case of chlorine compounds being used in vehicle-borne improvised explosive devices. Chlorine is an age-old chemical warfare agent from the World War I era. Now because of its ease of use, availability and toxicity, terrorists have resorted to using it to create mass casualties and panic (add footnote). This use of water purification grade chlorine validates one of the NIOSH risk assessment tenets used in analyzing the threat and eventually choosing GB and HD as the worst case "actor" compounds for respirator CBRN certification.

Multiple protections against toxic industrial chemicals, military genre chemical warfare agents and terrorist grade chemical weapons are warranted. The NIOSH-certified respirator with CBRN protection provide that level of respiratory protection to the trained user. While these protections are provided by the NIOSH-approved CBRN SCBA, the traditional NIOSH-approved SCBA does not have live chemical warfare agent tested hardened design and science that a CBRN SCBA does. That is why it is important to know the distinctions between a NIOSH-Approved SCBA and a NIOSH-Approved CBRN SCBA.

SPECIAL OPERATORS: Firefighters, emergency medical technicians, federal response agents, and explosive ordnance disposal (EOD) specialists are examples of SCBA users that benefit from the fire resistance protection of a CBRN SCBA. Law enforcement responders conducting breaching operations, entry, or rescue operations may also encounter fire hazards during clandestine lab intervention, barricaded suspect, or CBRN weapon threat mitigation incidents. However, law enforcement responders (LER), while needing fire resistance also require stealth technology and ease of use in a CBRN SCBA. They may also require enhanced ballistic protection of SCBA. LER need NIOSH-certified SCBA with CBRN protections that are silent operating units and do not compromise surprise or tactical approach.

MARKET FOCUS: Per recent stakeholder input and NIOSH attendance at law enforcement training events, a higher percentage of special weapons and tactics officers are training with and using SCBA. As municipalities continue to bid and evaluate CBRN SCBA, law enforcement officers are beginning to play vital roles in the selection of a type of SCBA for a municipality. In most cases, they prefer to have a SCBA that provides ease of use in weapons sighting, breathing, light and noise discipline, and protection from ballistic projectiles.

If a first responder wants to obtain details on CBRN personal protective equipment (PPE), i.e., how to procure equipment by line number and available marketing endorsements, the responder can contact a respirator manufacturer, contact NIOSH, or log on to the NIOSH Certified Equipment Listing (CEL) or the DHS funded, Responder Knowledge Base (RKB), search engine. The RKB search engine is a popular tool available to local and state officials seeking federal homeland security grants. The RKB search engine is provided by the National Memorial Institute for the Prevention of Terrorism (MIPT) and is located at http://www1.rkb.mipt.org/.

1-D-2. USE FEATURES

Unlike industrial workplace environments where hazards are characterized and expected to be controlled, hazards at a terrorist event are expected to be initially, or subsequently unknown or masked, and likely to be uncontrolled during the early phases of emergency response. First responders to a CBRN incident may encounter mild or severe to extremely hazardous conditions than those normally encountered in either industrial, civilian emergency response or low intensity military conflicts.

PURCHASE FOCUS: The NIOSH-approved CBRN SCBA provides the wearer with respiratory protection in potential, known, or unknown hazardous settings or environments. It may be used for entrance into and escape from atmospheres that are immediately dangerous to life and health (IDLH) and/or atmospheres that are oxygen deficient. All NIOSH-approved CBRN SCBA listed on the NIOSH website are NFPA and NIOSH CBRN compliant and may be used for traditional industrial hazardous material, firefighting, and CBRN/WMD incident response. Buyers beware though! Not all components or accessories offered by respirator manufacturers are NIOSH-approved for use on the NIOSH CBRN SCBA. Users should check with the manufacturer representative and the NIOSH approval label to confirm whether or not the part number of a respirator is NIOSH-approved and carries CBRN protection compliance. The approval label is printed on white paper and is required to be inserted in the user's instructions/manual for the SCBA.

INDUSTRIAL PRECEDENCE: Traditional/industrial SCBA that are used to fight fires or conduct law enforcement methamphetamine lab responses are not fully adequate for CBRN incident responses. Traditional "industrial protection" for respirators refers to industrial workplace respirators approved under NIOSH 42 CFR Part 84. This certification ensures that the industrial SCBA meets existing minimum SCBA performance requirements regarding respirator weight, service life indicators, gas flow, service time, carbon dioxide concentration, low temperature exposure, reliable use tests and human subject/man tests. The CBRN SCBA program adapted the industrial protections protocol and used those same industrial proven test measures to insure initial compliance for the CBRN SCBA.

OVER-PRESSURE/POSITIVE PRESSURE TRAIT: CBRN SCBA are compliant to all industrial standards and are traditional open circuit, positive pressure, or pressure demand apparatus respirators, with additional special CBRN protections. CBRN SCBA are respirator devices in which the pressure inside the facepiece, in relation to the immediate environment, is required to maintain a slight positive pressure on laboratory head-forms during both inhalation and exhalation cycles. This pressure phenomenon is called "over-pressure". It is deemed a protective quality of SCBA that creates a concept in the mind of the user that even if the seal is

broke, the over-pressure will push out contaminants and keep the user safe. While this positive pressure appears to be adequate for traditional SCBA used in industrial confined spaces, hazardous materials/hazardous waste operations and emergency response (HAZWOPER), and firefighting, concentrations of chemical warfare agents used in SMARTMAN boxes/confined spaces are not stopped by this positive pressure inhalation-exhalation cycle/over-pressure phenomenon on traditional industrial approved SCBA, and thus, industrial SCBA/non-CBRN SCBA are determined to be inadequate for CBRN incident response. The evidence is in the detection of chemical warfare agent in the breathing zones of tested SCBA while under NIOSH CBRN special testing procedures.

HAZMAT ATTITUDE: CBRN incident response has been referred to in some user communities as nothing more than "HAZMAT with an Attitude." CBRN respirator standards development and certification programs show that specific chemical warfare agent effects on non-CBRN protected SCBA and other respirators are more than the commonly known/expected hazardous materials effects on the same surfaces.

TERRORIST GRADE: Surviving a "terrorist grade" CBRN incident response will require that trained emergency responders use NIOSH CBRN approved respirators, use available live agent tested protective suits compatible with those CBRN respirators, and have the situational awareness that provides entry and escape confidence under severe CBRN conditions.

RESPONDER PSYCHE: CBRN hazards that are large in scale and severity are not expected to easily dissipate under normal environmental conditions. If and when CBRN agents are used, military and civilian history indicates that the trained responder may seek self-preservation first and then focus on the mission while expecting the personal protective equipment to provide its certified level of protection. The performance of the CBRN respirator will become an issue only if it is seen as contributing to deaths or injury during the course of the mission.

SYSTEM FOCUS: Users should be trained to interpret the approval label and become familiar with the numerous part numbers that make up an approved CBRN SCBA configuration. All of the part numbers, when fitted together in a specific proprietary system, create lifesaving features and benefits. Examples of these lifesaving/mission support features are the heads-up display (HUD), redundant, dual, and primary air-pressure gauges, PASS device, communications devices, cylinder neck valve assemblies, cylinder types and respirator end-of -service-time-indicators (EOSTI). These features on a NIOSH-approved CBRN SCBA respirator provide the user the operational status of SCBA before, during and after use.

Details describing traditional SCBA features like the HUD, air pressure gauges, EOSTI, RIC UAC/RIT fitting, by-pass valves, and cylinder valve interchangeability are as follows.

1-D-2-a. Heads-Up Display (HUD)

The heads-up display (HUD) is a design requirement for SCBA compliant to the NFPA 1981, 2002 edition or later editions. The HUD is visible to the wearer when the respirator is donned and operational. Depending on the type of HUD technology in use, a HUD can be mounted inside or mounted outside the facepeice. Its visible display shows cylinder pressure, system status and alert signals in the form of light emitting diode (LED) color readouts or other signal devices.

HUD DISPLAY: At a minimum, a HUD will display the remaining quantity of breathable air, measure real time cylinder pressure, and alert the user when the remaining quantity of breathable air is less than 50% full. Power sources for the HUD are usually electronic. Batteries used in the HUD, require a two-hour battery life alert feature. Wireless remote HUD or HUD with integral wiring are also available and the wiring is tested for strength and effectiveness.

NFPA IMPACT: Currently, several NFPA 1981 editions are applicable to CBRN SCBA in the field. Some fielded NIOSH-approved CBRN SCBA are compliant to the NFPA 1981 standard, 1997 edition. These CBRN SCBA do not have a HUD. The most popular edition of the NFPA 1981 standard, the 2002 edition, requires a HUD and most fielded CBRN SCBA are compliant to the 2002 edition. The next edition of NFPA 1981, the 2007 edition, effective December 20, 2006, will be the NFPA 1981 edition that new CBRN SCBA are compliant to.

1-D-2-b. Air Pressure Gauges

Pressure gauges indicate the quantity of breathing air remaining in the cylinder. Pressure gauges are required to be redundant and visible to the wearer at all times. The primary air pressure gauge can be a mechanical gauge that operates with the pneumatic air pressure of the SCBA or a visual signal continuously displayed as part of the facepiece heads-up display. Stealth features for air pressure gauges are per manufacturer design.

1-D-2-c. EOSTI: End-of-Service-Time Indicator(s)

EOSTI are indicators required to alert the user when the cylinder is low on air. They typically consist of either an audible alarm/whistle, a flashing LED light in the heads-up display of the facepiece, or a vibrating alarm. Depending on the edition of the NFPA 1981 requirement that was current during the year the CBRN SCBA was approved, some units could have more than one independently operating EOSTI. These redundant alarms are recognized by different human senses. Activation of the alarm of each EOSTI shall be independent of any other EOSTI.

1-D-2-d. RIC UAC or RIT Fitting

The rapid intervention crew/company universal air connection (RIC/UAC) male fitting also known as the RIC/RIT fitting, is an air connector that transfers or replenishes breathing air to the SCBA breathing air cylinder from an external source without the user having to remove the cylinder from the SCBA harness assembly. The RIC fitting is a design requirement only on CBRN SCBA approved under the NFPA 1981, 2002 editions and later. It is not present on NIOSH-approved CBRN SCBA certified under the NFPA 1981, 1997 edition.

1-D-2-e. By-Pass Valve/Purge Valve

High-pressure air from the SCBA breathing air cylinder is reduced as it passes through the first and second stage regulators, and further reduced to a variable low pressure volume of breathable "air" that is delivered to the facepiece at a rate determined by the physical demands of the user while attempting to maintain a positive pressure within the interior of the facepice. NIOSH approval requirements specify that the regulator must fail "open" or allow the continuous flow of air into the facepiece, or be equipped with a manual by-pass valve that

will override the failed regulator in the event the respirator's regulator fails "closed." NIOSH testing requires that the SCBA second stage regulator fail in the open position. In the event that a second stage regulator fails in the "closed" position, air will stop flowing into the facepiece. That failed second stage regulator can be manually by-passed by opening the red by-pass valve, to the purge/on position. Opening this red by-pass (purge) valve sends air flowing directly into the facepiece.

TYPES: Manufacturer's user's instructions specify how to use the by-pass valve in the event of a regulator failure. By-pass valves expend pressurized air at a higher rate than the second stage regulator and will deplete the air cylinder rapidly. There are two types of by-pass valves: constant flow by-pass valves and variable flow by-pass valves. By-pass constant flow valves are considered state of the art technology and commonly found on CBRN SCBA. Other types of by-pass values, such those on belt-mounted regulators of SCBA, currently do not have NIOSH CBRN approval.

1-D-2-f. SCBA Rated Service Time Interpretation and Common Understandings

A CBRN SCBA "system rated service time" is the same time concept associated with the rated service time of an industrial or non-CBRN SCBA. It is the length of time in minutes that an SCBA will continue to deliver breathing air to the facepiece at a specific use rate, tested in accordance with 42 CFR Part 84. This is a reproducible laboratory "bench test time" and this time is not equivalent to a human breathing performance time. Traditionally, the NIOSH system rated service times of breathing gas (air) cylinders are 30, 45 or 60 minutes in the United States. Rated service times are determined during NIOSH air capacity testing of the air cylinder.

30-minute Bottle. One commonly used practice is to identify the SCBA rated service time by verbally calling out the time value in minutes for a particular type of air cylinder/bottle. For example, SCBA may be known as having a 30-minute bottle, a 45-minute bottle or a one-hour/60-minute bottle. If a responder wanted to see the rated service time of a NIOSH approved SCBA, it is located on the SCBA backframe harness in the form of an adhesive NIOSH approval label, usually of rectangular dimension. The adhesive label color and printing varies by SCBA manufacturer but its location is standard as is the information on it, in accordance with 42 CFR Part 84. Rated service time is also explained in the NIOSH paper approval label inserted in the manufacturer's user's instructions and on the official electronic NIOSH assembly matrix.

Protection Code: An example of a typical rated service time on an inserted approval label is listed under the protection column of the label. The example can read "SC/PD/CBRN 30 min/4500 psig." Psig stands for *pounds force of pressure per square inch gauge* (excluding atmospheric pressure). This SC/PD/CBRN 30 min/4500psig translates into SC = Self-Contained, PD = Pressure Demand, CBRN is the additional protection category added, and "30 min" is the 30-minute rated service time at 4500 psig pressure duration rating. Different manufacturers may identify specific service times or pressure durations as part of the brand names of the SCBA, such as "4.5," "2.2," "3.0," or "L-30" etc. The official rated service time of a CBRN SCBA is approved, per the manufacturer's application request and the results of NIOSH testing.

One Assembly-Multiple Duration Bottles. While time or "rated service time", as it is formally called, is understood by the trained responder as the type of cylinder attached to the SCBA, such as a 30-minute, 45-minute or 60-minute bottle, the air pressure rating in psig of those same cylinders is not always as easily understood. For example, an open-circuit, pressure-demand, SCBA, capable of mounting 30, 45 or 60 minute

bottles may have a variable number of types of approved air pressures/ratings, 4500 psig, 3000 psig or 2216 psig, for those cylinders on one NIOSH approval label: resulting in a multitude of SCBA configurations for use. With a few exceptions, 2216 psig rated cylinders are typically not used on a 60-minute rated service time SCBA. An air pressure rating of 4500 psig is an example of an air pressure rating that can have all three types of rated service times (30, 45 or 60 minutes) in the form of different sized cylinders for an SCBA.

Actual Service Time. The NIOSH-approved rated service time of a CBRN SCBA is based on air consumption at a moderate work rate (40 liters/minute) performed under laboratory conditions. High work rates and differences in user lung capacity can significantly reduce or alter the actual service time achieved. As mentioned previously, CBRN SCBA rated service times are equivalent to the industrial rated service time ranges per the first tier of CBRN approval for SCBA. Add the NFPA compliance breathing rate as a requirement of the second tier of CBRN approval and the outcome is a CBRN SCBA that is capable of performing at multiple work rates. CBRN SCBA "actual service time" or cylinder capacity for in-use time is usually less than the rated service time indicated on the label, due to variables such as the physical condition of the user, the level of physical exertion, the initial cylinder start pressure levels, the ambient temperature of use, and other conditions.

CYLINDER EXEMPT FROM LAT: When the NIOSH benchmark survey was done in October 2001, 18 SCBA were evaluated by NIOSH and RDECOM. Actual service times of the cylinders were replicated by using house air shunted into the neck cylinder valve assembly. During this survey, breathing gas cylinders were attached to the SCBA per manufacturer's instructions and house air was shunted into the air pressure boundaries to allow for special chemical warfare agent test times to exceed the rated service time of the cylinder without physically removing the cylinder and refilling it during the test. Since that eventful bench mark survey was completed, it was determined that only the cylinder neck valve assembly of the cylinder and not the entire cylinder and cylinder neck valve assembly were needed for the SCBA LAT. Therefore, currently, SCBA seeking CBRN protection approval do not have cylinders tested against live agents, only their appropriate docking cylinder neck valve assembly is.

CREATION OF ADAPTER: To accomplish the exploratory benchmark testing NIOSH, RDECOM, and respirator manufacturers embarked on uncharted procedures and noted that they had to design tooled metal adapters to interface the incoming house pressure air to the SCBA. The appropriate cylinder neck valve assembly was adapted to a tooled adapter that interfaces with a house air pressurized air line cascaded to a dedicated industrial air compressor(s). Live chemical warfare agent contamination during the six-hour test prevents the quick fill or exchange of empty air cylinders for full air cylinders during the testing cycle, and thus, continuous cascading air pressure is maintained to the SCBA hardware, minus a cylinder, through the adapted cylinder neck valve. This eliminates the expensive and time intense task of decontaminating and destroying a DOT exempt pressurized vessel/air cylinder.

1-D-2-g. SCBA Cylinder Compliance

Breathing air/gas cylinders used with SCBA hardware are classified as air-compressed, UN-1002, pressurized vessels by the U.S. Department of Transportation. The DOT regulates the shipping, labeling, qualification, and periodic re-qualification of these pressurized vessels. Cylinders are manufactured by private sector cylinder manufacturers separate from the respirator manufacturers, as prescribed in 49 CFR 173 and 49 CFR 178, shipping container specification regulations of the DOT. The respirator manufacturer can provide

specific guidance on reading and interpreting the DOT markings on cylinders and how the hydrostatic test date markings are updated when a cylinder is re-qualified. OSHA requires that compressed breathing air for atmosphere supplying respirators, which includes the CBRN SCBA, must at a minimum, meet the requirements of Grade D breathing air described by the American National Standards Institute (ANSI) or the Compressed Gas Association (CGA) Commodity Specification for Air, G-7-1, 1989 [OSHA 1910.134 (i), (1), (ii)]. The NFPA 1989, *Standard on Breathing Air Quality for Fire and Emergency Services Respiratory Protection*, 2003 Edition, is also a reference.

NOTE: Interchangeable use of pure oxygen and breathing air in SCBA is not permitted in industrial or CBRN approvals.

REFILL: Quick charge, also known as "rapid fill/quick fill" is a process used to rapidly fill an empty air cylinder still mounted on the SCBA harness assembly while worn or unworn. Quick charge utilizes supplied air from a CGA-compliant cascade air supply source and is done only at the explicit discretion of the incident commander.

REFILL INTERFACE NOT LAT: Quick charge assemblies on CBRN SCBA are NIOSH approved as part of the CBRN SCBA air pressure boundary/respirator, but **not CBRN approved** for actual use in a CBRN environment because the interfaces required for safely connecting the quick charge fittings to external refill air sources are not live agent tested when mated. Approving the mated assembly involves certifying the air pressure boundary of another air source device that is not a respirator, and thus falls outside the scope of 42 CFR Part 84.

REFILL SAFETY: Users should ensure that all safety measures are enforced if quick charge operations are used. CBRN SCBA should be refilled in a prescribed air pressure refill operation procedure. Ensure mismatch of pressure ratings are not inadvertently mixed up during cylinder re-fill. This will prevent over-pressurization of cylinders and rupture of frangible discs.

CYLINDER INSPECTION: During cylinder recharging, numerous inspections of the cylinder and SCBA also can be performed. A CBRN SCBA user should inspect the air cylinder for the proper shape or roll of the cylinder to ensure that it conforms to an available standard, and to detect any unusual wear and tear indicators, any discoloration from burns, cracks in the cylinder thread or cylinder neck valve housing, or any clogged holes in the frangible/burst disc/plug in accordance with the manufacturer's inspection procedures. A full cylinder is then attached to the SCBA hardware and the SCBA is checked for proper pressure reduction between regulators by conducting user function checks on the SCBA.

HYDORSTATIC TEST MANAGEMENT: Typically, the maintenance management of DOT hydrostatic test dates and other related cylinder maintenance programs are controlled by the issuing fire department's qualified technicians. However, individual fire department standard operation procedures may require users to physically check the hydrostatic test date for expiration and process the cylinder for re-qualification. Fire departments that use the codes of the National Fire Protection Association (NFPA), specifically NFPA 1404 and NFPA 1500, know that these codes require regular maintenance checks of the hydrostatic test dates.

TRAINED TECHNICIANS FOR HYDROSTATIC TESTING/RE-QUALIFICATION: Law enforcement departments that use non-CBRN SCBA or CBRN SCBA should have officers or technicians trained by the respirator manufacturer on how to conduct SCBA maintenance programs. Mutual aid support from local fire department resources is also a very common, if not the most common, method for law enforcement responders to operate a SCBA maintenance program.

HYDROSTATIC TEST CODE: Hydrostatic test dates are permanently etched or labeled on air cylinders. Composite cylinders (carbon, fiberglass and Kevlar®) rely on epoxy resin label updates readable on the body of the cylinder in the form of a three figure code. The three-figure code (7 ^ 05) stands for the month-"7", followed by a unique inspector mark "^" and then the calendar year two digit number "05". This means the cylinder passed a hydrostatic test in July of 2005 and that test date expires per the type of cylinder. Other cylinder materials, such as aluminum, rely on metal digit imprints in the neck cylinder area, which are similar to the stated figure code example. Users should check with the respirator manufacturer or the cylinder manufacturer for additional guidance on hydrostatic test requirements and expiration information.

SUPPORTING ILLUSTRATIONS: Figures XX-1, XX-2 and XX-3, are generic examples showing a DOT exemption certificate label on a SCBA 4500 psig cylinder, used cylinders in a holding area, and a sample Carbon Fiber Composite Cylinder (CFFC) label, courtesy of Carleton Technologies Inc.

Figure XX-1: Generic breathing gas/air cylinder.

Figure XX-2: Empty cylinder stack showing field deployed condition and tagging.

Figure XX-3, CFFC example label showing nine parameters of a cylinder label.

1-D-2-g-(1) . Interchangeability of Cylinder and Neck Cylinder Valve Assemblies

NIOSH CBRN SCBA approval is voided if another cylinder and neck cylinder valve assembly, not listed on the NIOSH approval label, is attached to a different manufacturer's SCBA hardware. In crisis response situations where OSHA requirements are not enforced, interchangeability between like cylinder valves and cylinder dimensions is possible. The OSHA interpretation letter on cylinder interchangeability, dated June 20, 1997, is located at http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=23479

COMPONENT CALL-OUT: The attached *Appendix B, Components of a NIOSH-approved CBRN SCBA* depicts a schematic of a SCBA and shows the most common components and names on an air-hatch type CBRN SCBA. It is intended to be a generic example and does not necessarily show full accessories details in components such as the RIT/UAC, HUD, PASS or cylinder neck valve assembly and cylinder. For more detailed drawings consult with the SCBA manufacturer.

SUPPORTING ILLUSTRATION: *Figure XX, Air-flow pattern of SCBA cylinder* shows standard air-flow directions when the air source is the assigned cylinder. Blue arrows show air flow origin (A) relative to the location of the frangible disc (B), the hand operated valve (C), the air-pressure gauge (D) and the exit route (E) to the 1st stage pressure reducer/regulator.

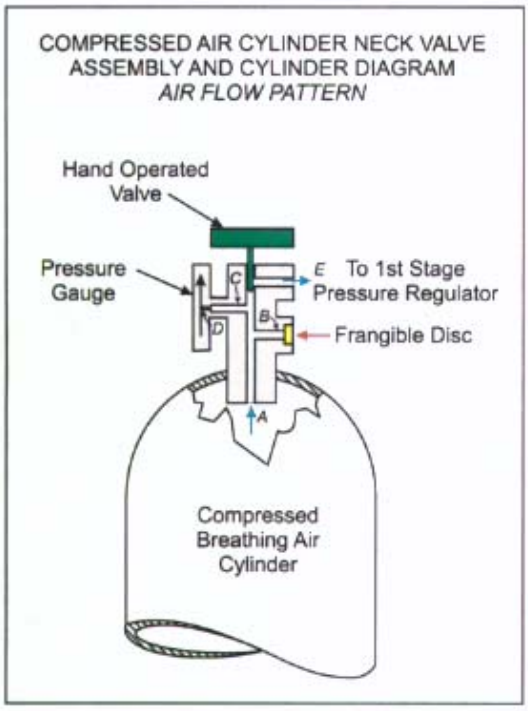


Figure XX: Air-Flow Pattern of SCBA Cylinder

1-D-2-h. User's Instructions

The manufacturer's user's instructions (UI) give detailed procedures for performing checks of components and accessories required on CBRN SCBA. Checks include an inspection of material integrity for signs of wear or damage and an operational check of the function of the components and accessories. The manufacturer will specify in the UI what checks are necessary based on the components and accessories particular to that CBRN SCBA model.

Among the checks which should be performed before use are:

- Inspection of facepiece components and accessories
- Inspection of backframe and harness assembly
- Check of cylinder valve assembly function
- Check of cylinder gauge function to ensure it reflects the cylinder is full

- Regulator function (both first stage and second stage regulators/air hatches, compact demand valves, mask mounted regulators etc. that are first breath activated)
- B-pass valve function
- Function of all end-of-service-time-indicators (EOSTI)
- Function of heads-up display (HUD)

- Check of integrity of hoses for cuts, abrasions, cracks, heat and chemical damage, and that the hose connections are tight
- Check that the hydrostatic test date of the cylinder is valid and not expired
- Check function of personal alert safety systems (PASS) if present
- User fit testing, seal check and technician leak testing of respirator

1-D–2- i. Fit Testing Requirements versus User Seal Checks

ATTENTION: TO ATTAIN MAXIMUM BENEFIT FROM THE CBRN SCBA, EACH END-USER MUST BE FIT TESTED BY AN ACCEPTABLE OSHA PROTOCOL AND ATTAIN A SATISFACTORY "FIT FACTOR" BEFORE USING THE IDENTICAL CBRN SCBA. FAILURE TO DO SO COULD RESULT IN INJURY OR DEATH.

USER SEAL CHECKS ARE NOT FIT TESTS. FIT TESTS ARE METHODICAL PROCESSES THAT CONFIRM THE SELECTED RESPIRATOR FACEPIECE SIZE IS THE CORRECT SIZE FOR THE ENDUSER/USER/WEARER/OPERATOR.

1-D-2-i-(1). Special Notes Concerning Fit Testing.

1. *SHAVING:* A clean shaven face is preferred. Proper training, supervised SCBA facepiece fit testing and a passing fit factor from the fit-test is required for the safe use of a NIOSH CBRN SCBA.

2. *PASSING TEST:* Successful fit testing of this NIOSH CBRN SCBA facepiece is required prior to use.

3. *NIOSH DEFINITION:* NIOSH defines a "fit test," per the October 2004 respirator decision logic, as: *the use of a protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual.*

4. *FIT TEST = SEAL CHECK:* Do not confuse fit testing with a user's seal check. They serve two different functions. An efficient user's "fit check" (as it is known in some workplaces) or user's seal check usually cannot be performed comfortably if a passing fit test is not attained.

5. *OSHA VS NON-OSHA:* Fit testing is required in respiratory protection programs of OSHA-compliant states and highly recommended in non-OSHA state programs.

6. *LIABILITY*: Failing fit factors from inadequately performed fit tests or inadequately sized facepieces could contribute to adverse effects on the respirator wearer and lead to potentially acute or chronic lifetime effects upon exposure to characterized or uncharacterised toxic or incapacitating hazardous atmospheres.

7. *USER SEAL CHECK:* User seal checks are routine checks that are done on a properly fit tested facepiece worn by an assigned user, to ensure a proper face-to-facepiece periphery seal interface. A proper systems function user check seal is attained after initially donning the facepiece, and as necessary, resealing the facepiece while in use to prevent inadvertent contamination penetration caused by the facepiece shifting on the user's face during routine use or increased levels of use.

8. *OPTICAL INSERTS*: See the CBRN SCBA respirator manufacturer user's instructions for additional information on fit testing and user seal/facepiece fit checks. Optical inserts are available for facepiece insertion. Do not don the facepiece while eyewear is still on face. Eyewear will not allow complete seal of facepiece to user.

9. *PERIODICITY:* A respirator will not provide its intended level of protection unless it *fits* the user properly. Proper fit means that the periphery seals of the respirator facepiece conform adequately to the user's face when properly wearing the respirator. The fit assures a level of known protection, provided the facepiece is maintained properly and donned correctly, each time. According to conversations with experienced fire department personnel, fit testing is performed on fire department personnel who are participating in the SCBA selection process for purchase and is one of the first actions a fire department does when a new SCBA is issued.

10. *LOGISTICS*: Routinely, the first action performed upon receipt of a new SCBA is to conduct a facepiece system leak test on a specific type of recognized headform test apparatus followed closely by human subject fit testing of employees. Fit testing is also a considered by responders as a possible resource constraint during the purchase specification development because thorough fit testing requires a leadership endorsement, a set amount of time, availability of responders, and fit testing equipment logistical preparations. To ensure that the department received a high-quality production model, most departments do SCBA system leak testing as a first time receipt action. If all SCBA systems meet the performance criteria for leak testing and pass, then facepiece size allocation, selection and donning are done and which is then usually followed by fit testing. The fit factor generated from compliant qualitative or quantitative fit testing methods determines the success or failure of the fit testing. SCBA, CBRN, facepieces require passing fit testing before use.

11. *QNFT and QLFT:* A *fit test* is defined in the NIOSH respirator selection logic as the use of a protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual (see also qualitative fit test (QLFT) and quantitative fit test (QNFT). QNFT is defined as "an assessment of the adequacy of the respirator fit by numerically measuring the amount of leakage into the respirator." QLFT is defined as a pass/fail fit test to assess the adequacy of the respirator fit that relies on the individual's response to the test agent. The QLFT and QNFT definitions are from the NIOSH Respirator Use Logic dated 2004 (http://www.cdc.gov/niosh/docs/2005-100/default.html).

12. *OSHA REQUIREMENT*: In the course of conducting a fit test, a defined and proven method is used to select a respirator size that provides the desired protective fit. Determination of facepiece fit is to be done by either a qualitative or quantitative OSHA-accepted protocol specified in Appendix A of the OSHA respiratory protection standard [29 CFR 1910.134]. The respirator program administrator is responsible for providing fit tests to respirator users prior to initial use of the respirator, whenever a different respirator facepiece (size,

style, model or make) is used, and at least annually thereafter to ensure continued, proper fit [29 CFR 1910.134(f)(2)].

Users should also undergo fit testing when changes in their physical condition occur that may affect respirator fit. Such conditions include, but are not limited to, facial scarring, dental changes, cosmetic surgery, or an obvious change in body weight [29 CFR 1910.134(f)(3)]. The OSHA respiratory protection standard [29 CFR 1910.134] mandates that tight-fitting facepieces, even for positive-pressure units, be fit tested in the negative pressure mode. The NIOSH CBRN SCBA is fit tested in the negative pressure mode..

13. *LRPL VALUE VERSUS OSHA FIT FACTOR:* The user should have the option to try on different sizes of CBRN SCBA facepieces (small, medium, and large, for example) converted to negative pressure configurations. In addition to the industrial fit testing for traditional NIOSH 42 CFR 84 certification, human test subjects used in CBRN SCBA laboratory respirator protection level (LRPL) are fit tested using quantitative calibrated particle analyzer machines to generate a LRPL value. In pre-LRPL trials, those individuals who are difficult to fit are tested on a TSI PORTACOUNT QNFT system to confirm the available size issued. Those same test subjects participate in the required corn oil chamber test trials during the LRPL testing phase. User seal checks, performed by the CBRN SCBA test subject without assistance from a second person or expert fitter, is known as "self-donning." Self-donning and user seal checks are taught in accordance with the most current manufacturer's user's instructions. Facial hair, scalp hair lines, hair buns, tied up long hair, or unshaven faces contribute to inadequate fit testing results. Unshaven faces, hair lines that extend into the face-blank sealing area, or hair buns that preclude the head harness from lying correctly also contribute to poor sealing characteristics and routinely generate failing results. Consult your local industrial hygienist or safety officer for technical assistance and training before attempting to conduct QNFT or QLFT.

1-D-2-i- (2). User Seal Checks and SCBA Facemask Fit Checks

DEFINITION: The user seal check is a method for determining whether a previously fit tested respirator has been properly donned and adjusted to ensure an adequate facepiece-to-face seal or "fit". NIOSH respirator selection logic defines a user seal check as "an action conducted by the respirator user to determine if the respirator is properly seated to the face." Respirator users should perform a user seal check every time the respirator is donned and before entering a contaminated area. A user seal check evaluates the seal of the respirator to the user's face by having the user don the facepiece under positive or negative pressure and checking for leakage.

OSHA: Effectiveness of the user seal check is dependent on the user or assistant detecting any audible or visual changes in the respirator indicative of an air pressure boundary leak. User seal check procedures are located in Appendix B-1 of the OSHA Respiratory Protection Standard [29 CFR 1910.134].

FACEMASK FIT CHECK: Manufacturer's user seal check procedures, which are located in the manufacturer's user's instructions specific to the model of the respirator, are normally compliant with this OSHA reference. Specific respirator manufacturer user's instructions may advise the wearer to conduct a 'facemask fit check' [Sabre SCBA User's Instructions, March 2003]. This facemask fit check is a user seal check.

TWO FINGER TECHNIQUE: The facemask fit check is a unique process done by the wearer while wearing the respirator. The SCBA is fully donned, the cylinder valve is on, and the system is charged/pressurized via first breath activation. The wearer then inserts two fingers into the mask face blank area to break the seal and determines if there is an outward flow of air (positive pressure). Once a sense of outward air flow is determined under ideal conditions and with no CBRN contamination present, the fingers are removed and the faceblank is allowed to reseal to the face. At this point wearers may be advised to stop breathing for a few seconds and check that there is no sound or air flowing from the second stage regulator. This method for checking the fit is not recommended for use in a toxic environment.

1-D-2-j. ACCESSORIES

An accessory is an item provided with a respirator that does not affect its ability to meet the NIOSH certification requirements of 42 CFR Part 84 [NIOSH SAP 2005]. CBRN approved accessories are listed as components of a respirator on the NIOSH approval label. However, in the case of CBRN protection approvals, submitted accessories must be attached and serviceable during the special CBRN LAT and LRPL trials. Batteries are not inserted in the personal alert safety system (PASS) devices because operation of the device does not expose the SCBA air pressure boundaries to ambient air and therefore, they are not exposed to NIOSH CWA test agents. CBRN SCBA accessories may include electronic voice amplifiers, affixed hardwire communications devices, spectacle (eyeglasses) kits, integrated PASS, stand alone PASS devices, fire service rescue belts and facepiece foam seal inserts.

1-D-3. PROTECTIONS

1- D-3-a. CBRN Protection

The majority of industrial SCBA show failing test results when exposed to vapor or liquid chemical warfare agents. CBRN protection is granted to manufacturers who voluntarily submit respirators to the NIOSH respirator approval program.

TRADITIONAL USE IN A NON-CBRN INCIDENT = DUAL-USE CBRN SCBA. When awarded the NIOSH-approval for CBRN protection, the SCBA is considered CBRN protected and capable of providing repeatable capabilities under known laboratory concentrations of chemical warfare agent. That same SCBA that demonstrates CBRN protection qualities must first comply with current NFPA fire resistance standards and NIOSH industrial standards. Based on the multiple tiers of protection the CBRN SCBA demonstrates, it is not a one-time-incident SCBA under normal use criteria. It can maintain its CBRN protective qualities while it is used in routine fire or hazardous material responses.

USE BEYOND 6 HOURS OF CWA CONTAMINATION IS NOT WORTH THE RISK. For the safety of the responder, NIOSH-approved CBRN SCBA has a defined in-use life when exposed to CWA. The CBRN SCBA is then truly a one-time-use respirator. Why? Because due to the known permeation and penetration

characteristics of chemical warfare agents and the inability of surface decontamination to totally neutralize the CWA on the CBRN SCBA the user should not assume the risk and use a contaminated CBRN SCBA more than one time within a six hour timeframe.

COMPLEXITY OF DESIGN VS SURFACE AREA CONTAMINATED. CBRN SCBA are significantly more complex compared to the engineering designs of CBRN air-purifying respirators. Numerous air-pressure boundaries exist in open circuit and closed circuit SCBA. CBRN agents do not distinguish between human or man made material surfaces. Specifically, chemical warfare agents rigorously attack all respirator materials, air pressure boundaries, and interfaces of SCBA, as they do in air-purifying respirators but to a lesser degree because typically the airborne exposure limits are expected to be lower for effective use of an APR and there are fewer existing air pressure boundaries in a full face tight fitting APR. CBRN PAPR and next generation hybrid SCBA-PAPR systems are expected to increase the user complexity of field use respirators. Despite the caustic physical constants of known CWA, CBRN SCBA design requirements and technology have made rapid advances over the past three years to ensure that any given approved design allows the SCBA to provide the minimum amount of quantifiable chemical agent protection, as determined under ideal laboratory conditions.

VENTURI EFFECT and BERNOULLI'S PRINCIPLE. For example, if there is air pressure flow variation due to respirator valve orientation, material porosity, or tooling design, GB exhibits unique chemical traits that allow it to penetrate and permeate the materials or flaws and potentially create agent equilibrium between the interior of the respirator and the exterior GB concentration. The Venturi effect may account for why GB and HD penetrate between static and cyclic air-pressure boundaries of select respirators and, in fact, gain variable access to the breathing zone of an SCBA. Parameters of this same Venturi effect, coupled with the dynamics of Bernoulli's Principle, could explain why so-called dead spaces harbor CWA. These dead spaces, also commonly referred to as compartments/chambers, do not experience the air flow dynamics of air exchange and have "dead air" spaces, consequently, it is theorized that these dead air spaces allow GB aerosol/vapor to collect and start actively penetrate/permeate the respirator, instead of being flushed out by air exhalation cycles. This process of dead space air exhalation cleaning has been demonstrated during NIOSH certification to be one of the proven engineering design controls used to protect air pressure boundaries against GB penetration or permeation, and thus increase the protective qualities of a specific respirator. Further research and study is required to determine the validity of the Venturi effects and Bernoulli's principle as they relate to the penetration and permeation characteristics of GB and HD chemical warfare agents. (ADD FOOTNOTE Source on Venturi Effect and Bernoulli's Principle)

SILICONE PLIABILITY VS PERMEABILITY/POROSITY. It is a commonly understood phenomenon that GB aerosol/vapor will penetrate or permeate silicone material surfaces that are used as respirator air valves or facepiece materials, provided there is minimal, to zero air flow/dead air, over a material surface. US Army laboratory experiments show that various thicknesses of silicone material "swatches" will allow permeation and penetration of GB, HD and VX, at various time intervals. While silicone is recognized as an ideal air pressure boundary for industrial use because of its pliability and unique soft texture, its use in a CBRN approved respirator is limited by the fact that it allows agent to penetrate or permeate it.

SILICONE INNER FACEBLANK with OUTER BUTYL LAYER/SKIN. U.S. Army RDECOM findings indicate that the amount of chemical warfare agent that passes through silicone is dependent on the level of GB concentration gradient, silicone material thickness, and time of exposure. NIOSH certification data shows

that GB and HD hardened/resistant materials that do not contain silicone but typically have blends of butyl rubber, neoprene, and/or nitrile or polyvinyl chloride, appear to be ideal protective materials when tested under live agent test laboratory conditions. See the NIOSH emergency response cards located at http://www.bt.cdc/agent/sarin/erc107-44-8pr.asp, .../vx/erc50782-69-9pr.asp....and /sulfurmustard/erc505-60-2pr.asp for additional guidance on CDC recognized types of personal protective equipment.

SILICONE IS STILL VIABLE FOR OTHER USES. Currently, silicone materials are common in many types of industrial and NFPA compliant respirators. And select NIOSH-certified respirators with CBRN protections still contain silicone materials, albeit the silicone materials are not in the air-pressure boundary that can lead to the breathing zone or are effectively covered by a CBRN hardened material. For select applications such as a biological agent response, silicone materials are still used. However, in those chemical warfare incidents where use of a silicone blended respirator is unavoidable, please ensure all outer silicone surfaces are completely insulated through use of a butyl second skin overtop of the silicone surface.

LAB TEST CONDITONS VERSUS REAL LIFE CONDITIONS. NOISH laboratory conditions, at standard temperature and pressure (STP), when practical and feasible, mimic real-life use conditions as close as possible using defined technical methods, surrogate breathing headform apparatus and human test subjects. Users need to know that those same laboratory conditions are not expected to fully replicate actual CBRN SCBA field use conditions of all possible venues of terrorist CBRN attacks. The NIOSH CWA concentration values used in certification are based on the most credible chemical warfare agent event predicted parameters and refined with safety factor formulas to generate a pass/fail criteria for respirator performance. The NIOSH special CBRN tests do replicate rigorous repeatable laboratory processes that stress CBRN SCBA air pressure boundaries and external material compositions. Contamination concentrations are known and calibrated laboratory equipment allows the controlled observation, documentation and quantification of agent exposure affects resulting in certifiable test results for NIOSH approval letters. The fact that a confined space is created in a laboratory environment produces conditions that replicate various worst case scenarios that may in fact occur in the field environment workplace.

HARD COATED SURFACES. Material surfaces that are treated with various "hard coats" may serve as barriers to the affects of CWA. Hard, non-porous surfaces, like coated polycarbonate, will allow liquid HD droplets to bead and run/drain off. NIOSH tests show that a hard coated lens of a SCBA respirator will likely not allow the faceblank lense to be permeated unless the HD/Blister agent is allowed to collect in a lip or threaded area. If the HD agent is allowed to collect in an area of the respirator, NIOSH and U.S. Army tests show that HD permeates and grazes the material contaminated with HD over time.

QUICK APPLICATION OF A DECONTAMINATION TECHNIQUE REDUCES HD CONTACT TIME. Timely gross decontamination with a decontaminant solution or water and soap is expected to slow the permeation effects of select CBRN agents such as HD, GB and VX [NIOSH Sarin, Mustard and VX Emergency Response Cards. 2004]. Liquid HD is known to aggressively attack thin plastic membranes, silicone membranes, stress points where two like or different materials interface, and other porous surfaces, causing pressurized or mated surfaces to violently expand, crack, and physically crumble under slight external pressure, changes in pneumatic pressures or changes in material compositions of like components.

CREDIBLE EVENT or ANTICIPATED EVENT. CBRN protected respirators, tested and approved in laboratory environments, are currently designed to protect against CBRN agents in what has been commonly

referred to as a "credible event(s) or anticipated event." The phrase "credible event" is confused with what is also known as "worst case (use) conditions/event." Credible events are not necessarily the worst case conditions that a CBRN event can generate, although they certainly can lead or create worst case events. Credible events are events that are predicted the most practical and possible based on available scientific dispersion models, real life tests of known or suspected CBRN dispersal techniques and available human intelligence information on adversarial CBRN threat capabilities. Typically, military grade CBRN agents are expensive to obtain, dangerous to handle and transport, and difficult to deliver by the moderately trained or untrained person and therefore their presence in an investigation can lend credibility to the threat. If terrorist grade CBRN agents are used in an attack, the prior existence of a managed respiratory hazards protection program focused on the proper use of NIOSH-certified respirators with CBRN protections is expected to contribute to the preparedness level of emergency responders. Advertisements displaying emergency responder's preparedness may also divert the terrorist's interest in investing time, energy, and resources in constructing and attempting a CBRN attack.

ACTUAL THREAT. U.S. anthrax responses during the autumn of 2001 and other known CBRN type events compiled and analyzed by the Monterey Institute of International Studies (MIIS) in 2001, show various degrees of credible chemical and biological terrorist attacks executed in the U.S. and the international community. Chemical warfare agent attacks initiated by the Japanese religious cult Aum Shinrikyo, now called Aleph, occurred from April 1990 to April of 2000 in Japan. CBRN agents of choice for the Aum Shinrikyo cult were VX, GB, variations of anthrax cultures and anthrax vaccine strains, variations of botulinum cultures, phosgene, hydrogen cyanide, sodium cyanide, sulfuric acid mixtures and hydrogen fluoride. The use of radiological agents by the cult, in the form of dirty bombs, was not identified by the MIIS 2001 assessment. However, MIIS did identify radiological incidents or "rad attacks" as termed by the MISS that were planned and foiled. Recently, Polonium -210 (Po-210) an alpha emitter radionuclide, has been identified as a possible health concern as of November 30, 2006 [CDC 2006].

CBRN agent physical constants (density, vapor pressure etc.) make them ideal inhalation threats and thus, the respiratory system is considered by most scientists as the primary route of entry into the human body followed by dermal exposure.

UNPROTECTED PERSONNEL. Unprotected personnel have historically been the targets of deliberate chemical warfare agents or chemical irritants attacks since World War 1. Chemical irritants known as "tear gas", the riot control agent "CS", "mace", "pepper spray" or other irritants were sprayed in the first class cabin of the American Airlines Flight 11 commercial jet during the September 11, 2001,terrorism attack [9/11 Commission Report, page 5, 2004]. Since mace spray is easily concealed, transporting it onto the aircraft was not detected. Use of the irritant may have been done to force passengers and flight crew toward the rear of the aircraft to contain them and remove them from the first class passenger area The use of an irritant on American Airlines 11 shows the aptitude of the terrorist for chemical irritants and chemical warfare agents, the terrorist's acclimatization to chemical irritants since they did not use respirators of any type during the onboard release and the terrorist knowledge of the immediate effects of irritant particulate agents in confined spaces as well as the psychological outcomes of mental and physical intimidation and terror.

Integrating CBRN agents into a focused pre-planned terrorist attack is not expected to be easy for the terrorist, however, if the 9/11 attacks are indicators of terrorist planning capability and mission execution, the potential

use of CBRN agents or riot control agents in future terrorism incidents cannot be discounted. [http://edition.cnn.com/SPECIALS/2002/terror.tapes/] [Intell Center, 2003]

AIRBORNE EXPOSURE LIMITS. CBRN protection to the respiratory system of humans made available by respirator manufacturers meeting NIOSH respirator performance standards is the highest level of respiratory protection available. And when properly maintained, stored, and used, it is expected to provide that level of protection for the life of the respirator. However, emergency response guidelines for CBRN terrorist events should be based on scientifically established exposure/contamination limits for all known agents or materials involved. The most relevant guideline for radiological dirty bomb response is published by the National Council on Radiation Protection and Measurements (NCRP). In 2001, the NCRP published Report- 138 entitled *Management of Terrorist Events Involving Radioactive Material.* They are currently funded by the CDC to generate *Population Monitoring and Decontamination Following a Nuclear/Radiological Incident* findings from a NCRP Special Committee 4-2 (SC 4-2) which recently met on November 14-15, 2006. Re-evaluation of chemical warfare agent airborne exposure limits is ongoing and biological airborne exposure limit development has essentially just started. [Sabelnikov et.al., International Journal of Environmental Health Research, 2006]. With that understanding, chemical warfare agent airborne exposure limits based on U.S. EPA and NRC AEGL values are relevant and therefore serve as the basis for NIOSH-certified respirator CBRN protection performance values. The types of CBRN agents are now briefly discussed to show relevant cautions and limitations applicable to the NIOSH-approved CBRN SCBA.

1-D-3-a- (1). NERVE AGENTS

NIOSH knows that GB penetrates non-CBRN respirators and respirator materials at varying rates. The GB used in NIOSH LAT is liquid GB which is then heated to generate a vapor and a vapor-aerosol mixture used in NIOSH testing. The liquid and aerosol-vapor mixture is colorless. It does not cause visible changes or effects on the SCBA in a SMARTMAN chamber. It is detected by calibrated sampling and monitoring apparatus and rigorously tests the material protective qualities of a respirator designed to protect the human breathing zone. Follow on decontamination methods for respirators contaminated with GB are extensive because of the pervasive penetration characteristics of the agent. Sampling and monitoring quantitative redundant technical methods are the only known detection methods for GB in the NIOSH laboratory. Per U.S. Army field manual 3-11.9, January, 2005, GB decomposes in 2 and ½ hours at 150 degree Celsius and hydrolyzes in 80 hours at pH 7.

SARIN. GB, or Sarin nerve agent, is a volatile liquid at room temperature. Contracted agencies to NIOSH use GB in a liquid/aerosol and vapor state by heating it before agent dispersion. At room temperature it has the consistency of tap water. Library records show that the name SARIN is derived from the four German scientists who invented it: **S**chrader, **A**mbros, **R**udriger and van der L '**IN**'de [Library.thinkquest.org]. They invented several G-series agents with GA being the first followed by GB and GD. V-series nerve agents were also later invented by the United States and the United Kingdom. VX, a highly toxic persistent nerve agent, has a consistency similar to motor oil. It is not likely to be volatile, but in conditions involving explosions, it could aerosolize/vaporize and disperse into the air just like GB. A technology that takes these chemical warfare agents and applies them to particulates in an effort to defeat the protective qualities of military personal protective equipment is thought to exist in the form of dusty CWA. The introduction of "dusty CWA" or "next generation/novel CWA" into terrorism activities may warrant further research into the effects

of dusty agents or novel agents on CBRN respirators. Additional information on nerve agents can be found at the following NIOSH website:

NIOSH emergency response cards http://www.bt.cdc.gov/agent

1-D-3-a - (2). BLISTER AGENTS

HD is a liquid at ambient temperatures, but can vaporize on its own or be dispersed as a vapor in an explosion. HD, in the liquid state, permeates surfaces at the molecular level and can cause select materials to become brittle, break, or expand rapidly. HD clear liquid droplets with a slight yellow tint are visible on the SCBA during NIOSH LAT. As expected, HD vapor is colorless. Military M8 litmus paper does change color upon contact with HD liquid in the chamber. HD vapor and liquid contamination will cause non-CBRN hardened respirators to catastrophically fail in select areas were pneumatic pressures are exerted on material surfaces that are not CBRN/Chemical Warfare agent hardened.

Additional information on sulfur mustard can be found at the following website:
NIOSH emergency response card for HD (sulfur mustard)
http://www.bt.cdc.gov/agent/sulfurmustard/erc505-60-2pr.asp

1-D-3-a – (3). BIOLOGICAL AGENTS

Biological agents are particles that will not penetrate the materials of properly assembled and fitted respirators or protective clothing. Some terrorist or state-sponsored devices may have the capacity to disseminate large quantities of biological agents or materials as aerosols. Biological agents may be dispersed in the form of liquid droplets, liquid aerosols, solid aerosols, or as a powder of bacterial spores.

The CBRN SCBA provides protection against airborne biological terrorists' threats including anthrax, brucellosis, Glanders, pneumonic plague, tularemia, Q Fever, smallpox, Venezuelan equine encephalitis, viral hemorrhagic fevers, T-2 mycotoxins, botulism, ricin, and staphylococcus enterotoxin B. NIOSH respirator policies state that under specific conditions, a properly worn and fitted traditional SCBA reduces the user's exposure to industrial hazards by a factor of at least 10,000. This reduction is true whether the hazard is from airborne industrial particles, industrial chemical vapors or industrial gases. CBRN SCBA also have the same minimum level of assigned protection, plus enhanced material protection factors not inherent in traditional industrial SCBA. Other types of respirators that provide lower levels of assigned protection are generally allowed in the workplace, once conditions are understood, defined, and exposures are determined to be at considerably lower levels due to engineering controls, portable forced air ventilation or fitted PPE.

Additional information on bioterrorism agents can be found at the following website:
http://www.bt.cdc.gov/agent/agentlist.asp

1-D-3-a – (4). RADIOLOGICAL and NUCLEAR AGENTS/EFFECTS

Radiological agents and nuclear detonation effects create airborne particulate matter (liquid and solid aerosols), which are radioactive or have the ability to carry radioactive particles (i.e., alpha and beta particles released from the atomic nuclei of an unstable isotope can cling to dirt particulates). The CBRN SCBA

provides protection from breathing this particulate-borne radiation by protecting against particles suspended in air.

Protection is not provided against high energy gamma radiation, which consists of the emission of photons from the atomic nuclei of a substance undergoing radioactive decay. Protecting responders from high energy gamma radiation requires minimizing exposure time, incorporating the use of special shielding garments, and maintaining appropriate distance from the source, based on the measured radiation exposure values at the site.

NOTE: Protection is not provided against the explosive blast and shock waves of a conventional or nuclear detonation. The resulting high velocity debris, will likely impact the user and the worn respirator.

Radiological refers to particulate-borne radiation dispersed by detonation of a radiological dispersive device (RDD) or a radiological improvised explosive device (R-IED), also known as a "dirty bomb." An RDD is understood to be a conventional explosive device that has been surrounded by or contaminated with some form of radioactive isotope material. Polonium-210, since it is an alpha-emitter radionuclide, it would have to be ingested, breathed or introduced by penetration to be an effective radiological isotope weapon. And even then it would serve to be used in isolated cases and not necessarily represent an ideal candidate for an RDD mass disruption weapon.

Nuclear refers to particulate-borne radiation dispersed by detonation of an improvised nuclear device (IND) or a nuclear warhead. An IND is intended to cause a nuclear explosion, and could consist of diverted nuclear weapon components or a modified nuclear weapon. Unlike an RDD that can be made with almost any radioactive material and a conventional detonation source, an IND requires fissionable material—highly enriched uranium or plutonium—to produce a nuclear yield and generate a hazard. NIOSH-certified respirators with CBRN protection will stop airborne radioactive particulates through assigned protection factor and filtration science but not deter the gamma energy of radioactive waves or kinetic energy.

Additional information on radiological and nuclear agents can be found at the following website: http://www.bt.cdc.gov/radiation/index.asp

1-D-3-a – (5). UPGRADE or RETROFIT to CBRN Protections

Retrofitting a field deployed SCBA to CBRN protection compliance is required to be done by an authorized manufacturer trained technician or the SCBA manufacturer. Use criteria for selecting a field deployed SCBA for retrofitting to NIOSH CBRN protections are established by the respirator manufacturer. Application of the specified retrofit kit designed by the manufacturer is the responsibility of the manufacturer or a designated representative and required to be installed per the NIOSH-approved CBRN Retrofit kit and instructions.

In 2002, NIOSH implemented a program to certify CBRN retrofit kits for field deployed SCBA, see the link http://www.cdc.gov/niosh/npptl/resources/pressrel/letters/lttr-031103c.html . SCBA units that were placed in service prior to issuance of CBRN approval may be upgraded to CBRN approval status through this program. Respirator users can contact the manufacturer of their current SCBA to see if a NIOSH-approved CBRN SCBA retrofit kit is available.

1-D-3-b. TOXIC INDUSTRIAL CHEMICALS PROTECTION

Toxic Industrial Chemicals, or Toxic Industrial Materials (TIC, TIM): TIC and TIM are chemical elements, compounds or materials used in industrial applications. They exist in physical states as gases, vapors, liquids, solids, or particulate aerosols. The difference between a TIC and a TIM is the physical state of the compound and whether the compound is mixed with other compounds or undiluted.

1. D-3- b- (1). Toxic Industrial Chemicals (TICs)

Toxic industrial chemicals are a variety of industrial chemical compounds or elements used in civilian or military industrial processes that can kill, seriously injure, or incapacitate people, if inadvertently released into the workplace or environment. Toxic industrial chemicals are normally in bulk storage containers of solitary chemical compounds used to support industrial businesses in the manufacturing of a specific industrial product. The quantity and type of TIC determines emergency response policies regarding evacuation or sheltering in place from local and downwind hazards. Chlorine (CL2) is considered a TIC due to its prevalence in industry. While its previous use as a classic chemical warfare agent during World War I is documented, it is currently unlikely that it would be used a military chemical warfare agent due to its high volatility and inability to maintain sufficient concentration on a target. Anhydrous ammonia (NH3) is also considered a TIC. These are just two of many TIC found in industry. The toxicological differences of TIC versus chemical warfare agents are significant. CWA are more toxic than TIC and require a smaller quantity of CWA to attain the same effects that a larger quantity of TIC would attain.

1. D-3- b- (2). Toxic Industrial Materials (TIMs)

Toxic industrial materials are a variety of industrial chemical mixtures that are usually stable/compatible and used in civilian or military industrial processes that if used inadvertently, can kill, seriously injure, or incapacitate people. Toxic industrial materials are often comprised of more than one toxic industrial chemical or compound. An example of how a TIM is produced is the use of an industrial waste storage press that generates solid sludge waste for controlled disposal in industrial roll-on/offs bed containers. Industrial sludge is a TIM and not necessarily a TIC. Industrial chemical waste by-products, transported in environmental waste roll-offs, may also be considered TIM. Examples of TIMs are phosphine, ethylene glycol dinitrate, 1, 1-dimethylhydrazine, acetylene, butane, cyclopropane, ethylene, methane, propane, and gasoline.

1-D-3-c. OTHER HAZARDOUS ATMOSPHERES

1. D-3-c-(1). Unknown Atmospheres

NIOSH approved CBRN SCBA are expected to provide protection against unknown toxic compounds and oxygen deficiency in unknown atmospheres. Air-purifying respirators (APR) of any type are not recommended in lieu of SCBA or supplied air respirators (SAR) for these atmospheres. Read the following link http://www.cdc.gov/niosh/npptl/topics/respirators/cbrnapproved/apr/default.html to understand why a CBRN SCBA is recommended over a CBRN APR for use in unknown atmospheres or atmospheres that are expected to be high in toxic compounds.

Unknown atmospheres are expected to be those atmospheres in which the contaminant type and concentration is not known by the user prior to entry. A CBRN SCBA may be used for emergency or planned entry into

unknown atmospheres provided the scene is secure, and proper two-man entry rules are in effect per local incident command authority. Additionally, current CBRN SCBA are not required to be intrinsically safe (IS) and therefore, lower explosive limits (LEL) must be determined to be at safe levels before use and entry.

1-D-3-c-(2). Immediately Dangerous to Life or Health (IDLH) Atmospheres

NIOSH-approved CBRN SCBA provides protection against atmospheres at or close to levels considered immediately dangerous to life or health (IDLH). According to *NIOSH Respirator Selection Logic, (October 2004) and NIOSH Interim Recommendations for Firefighters and Other First Responders for the Selection and Use of Protective Clothing and Respirators Against Biological Agents*, one of the most protective respirators is the self-contained breathing apparatus equipped with a full facepiece, operated in a pressure-demand mode. CBRN SCBA meets the criteria and is recommended for use in an IDLH atmosphere. This type of respirator is also recommended for entry into confined spaces created by natural disasters, firefighting, entry into oxygen-deficient atmospheres, emergency situations, and entry into an atmosphere that contains a substance at a concentration greater than 2,000 times the NIOSH recommended exposure limit (REL) or OSHA permissible exposure limit (PEL) for a compound [NIOSH Pocket Guide, 2004]. The SCBA, CBRN, is not recommended for submersible/underwater use.

NIOSH POCKET GUIDE. The current NIOSH definition for an IDLH exposure condition is stipulated in *NIOSH Respirator Selection Logic* [NIOSH Publication No. 2005-100]. Additionally, it can be found in the *NIOSH Pocket Guide to Chemical Hazards* http://www.cdc.gov/niosh/npg/npg.html .

In these documents, IDLH is defined as "conditions that poses an immediate threat to life or health or conditions that pose an immediate threat of severe exposure to contaminants, such as radioactive materials, which are likely to have adverse cumulative or delayed effects or to prevent escape from such an environment. The purpose of establishing an IDLH exposure level is to ensure that the worker can *escape* from a given contaminated environment in the event of failure of the respiratory protection equipment.

DECISION LOGIC. The IDLH is considered a maximum level above which only a highly reliable breathing apparatus providing maximum worker protection is permitted. Any appropriate approved respirator may be used to its maximum use concentration (MUC) up to the (known) IDLH concentration." The original definition of IDLH was derived from 30 CFR 11.3(t) and the concept of incorporating a safety margin using standard completion program IDLH values was based on the effects that might occur as a consequence of a 30-minute exposure. However, the 30-minute exposure was NOT meant to imply that workers should stay in the work environment any longer than necessary; in fact, every effort should be made to exit immediately. [NIOSH 2005]

1-D-3-c-(3). Oxygen-Deficient Atmosphere

An oxygen-deficient atmosphere is defined by NIOSH as an atmosphere with an oxygen concentration below 19.5% by volume. The minimum requirement of 19.5% oxygen at sea level provides an adequate amount of oxygen for most work assignments and includes a safety factor. The safety factor is needed because oxygen-deficient atmospheres offer little warning of the danger, and continuous measurement of an oxygen-deficient atmosphere is difficult. Oxygen concentrations below 16% at sea level produces decreased mental effectiveness, visual acuity, and muscular coordination, and below 6% oxygen, death will result. Often, only

minor subjective changes as indicators are noted by individuals exposed to low concentrations of oxygen and collapse of the individual can occur without warning. Since oxygen-deficient atmospheres are life-threatening, only the most protective respirators are recommended. The most protective respirators are pressure-demand self-contained breathing apparatus or the supplied-air respirators with auxiliary self-contained escape bottles for industrial operations and the CBRN SCBA for CBRN incident operations. See the respirator selection logic link at http://www.cdc.gov/niosh/docs/2005-100/default.html for further information.

GRADE "D" AIR. NIOSH recommends a supplied air breathing system to ensure adequate levels of oxygen for working in oxygen-deficient atmospheres. The NIOSH approved CBRN SCBA carries an independent supply of compressed gas/breathing air that is not connected to a stationary breathing air source. A compressed gas/breathing air supply is required by 42 CFR 84 to meet the applicable minimum grade requirements for gaseous air set forth in the Compressed Gas Association *Commodity Specification for Air, G-7-1*, 1966 (Grade D air or higher quality) publication. Compressed oxygen cannot be used in a device designed for compressed breathing air (an SCBA cylinder) and is not recommended by NIOSH. In fact, 42 CFR 84 prohibits certification of any device designed to permit interchangeable use of oxygen and air. It is a general practice safety rule that elemental oxygen can never be used in a device unless it is specifically designed for that purpose.

Scuba VS. SCBA. Grade D or E air is also used in self-contained underwater breathing apparatus (Scuba), which may be compliant to EN 14153-1 or EN 14413-1, in accordance with certification training programs endorsed or published by the Professional Association of Diving Instructors (PADI). See the following website for more information on Scuba: http://www.padi.com/english/default.asp?o=am.

Chapter 2: Administrative Labels, Cautions, and Limitations

2-A. NIOSH ASSEMBLY MATRIX

ASSEMBLY MATRIX. A respirator system matrix composed of system part numbers and component part numbers that make those specific respirator systems. NIOSH CBRN SCBA part number configuration management is done by specific software that records, manages, and compares numerous data files on an SCBA. This generates a master part number and equipment description matrix called the NIOSH assembly matrix, which is maintained in proprietary confidence by NIOSH/NPPTL. This assembly matrix is normally an electronic file that shows a table of major subassemblies and accessories assigned to a particular respirator system. The assembly matrix is the technical parts data for the NIOSH approval label paper insert located with the manufacturer's CBRN SCBA user's instructions.

STANDARD APPLICATION PROCEDURES. The NIOSH standard application procedures for the certification of respirators (SAP) define an assembly matrix as a table of major sub-assemblies and accessories. In this SAP, a typical CBRN SCBA assembly matrix may list both industrial SCBA part numbers and CBRN part numbers or may be a distinct CBRN SCBA assembly matrix that simply tracks CBRN SCBA component part numbers.

2-B. NIOSH APPROVAL LABEL

Only respirators affixed with an adhesive CDC NIOSH "CBRN agent approved" label as shown in Figure XX, are certified by NIOSH for use in CBRN environments. Effective December 5, 2005, a new NIOSH CBRN Agent Approved label replaces the CDC NIOSH CBRN Agent Approved label. The difference is the CDC logo is removed from the December 5, 2005, version, leaving the NIOSH logo the remaining logo.

To determine if a respirator is CBRN-approved do the following:

- **Look to see if the CBRN agent approval label is on the respirator. It can be any font size with a black and white letter scheme, located in a visible space on the backframe assembly and required to be exactly like Figure XX. If this CBRN agent approved label is not on the SCBA, the device is not approved by NIOSH for use in CBRN environments.**

- **Check for the presence of the NIOSH "CBRN agent approved" adhesive label to avoid errors! If the label is worn off or unreadable, contact the manufacturer. Ensure that you read the user's instructions for all required component part numbers, accessory part numbers, and special NIOSH cautions and limitations prior to use.**

- **The following two labels are examples of the two different types of "CBRN Agent Approved" adhesive labels likely to be found on NIOSH-approved CBRN SCBA in the field. The lower label is the new version that was effective December 5, 2005. For a period of time, both the old CBRN Agent Approved adhesive label with the CDC logo and the NIOSH logo will be in the field and eventually replaced by the new NIOSH only logo label for CBRN Agent Approved SCBA.**

Figure XX-1. SCBA CBRN Agent Approved Adhesive Label.

Figure XX-2 showing the new NIOSH CBRN Agent Approved label effective December 5, 2005.

- *USER INSTRUCTIONS.* Additional information is provided on NIOSH matrix-style approval labels (paper copy matrix formats) found in the user instruction manual for the respirator. The user instruction manual is shipped by the manufacturer with the respirator. The instructions manual, operating manual, operations manual, or user's instructions outline the general safety information, warnings, cautions, limitations, liabilities, and special instructions for the CBRN SCBA as defined by the manufacturer. These CBRN SCBA UI clearly state that CBRN SCBA are intended for use by personnel who have successfully completed a manufacturer's training program. In some emergency responder departments, SCBA are mistakenly not considered respirators and therefore not subject to expected respirator use cautions and limitations. In these same departments, the term "respirators" is equated to "gas masks" only and SCBA are not considered respirators but simply, breathing apparatus (BA) or air tanks. Users need to know that SCBA are respirators and that SCBA have limitations of use just like any other class of respirators approved by NIOSH.

- *SCBA ARE RESPIRATORS.* While manufacturer user's instructions or operations manuals routinely refer to CBRN SCBA simply as self contained breathing apparatus, SCBA are, in fact, a separate class of respirators and not just simply self-contained breathing apparatus or breathing apparatus (BA).

- *TECHNICAL CERTIFICATION NUMBERS (TC NUMBERS) WITH CBRN.* Separate classes of NIOSH approved respirators routinely have separate technical certification (TC) approval numbers. The approval number or TC number for a CBRN SCBA respirator includes a **CBRN** suffix attached to the TC-13F number (TC-13F-XXXXCBRN). The Xs represent sequential administrative numbers assigned by NIOSH.

- **NOTE: If the approval number on the paper label does not include a CBRN suffix, it is not certified by NIOSH for use by emergency responders in CBRN environments.**

- ***HOW TO READ A NIOSH LABEL, PAPER COPY.*** **The complete CBRN assembly must be composed of only those component parts/part numbers listed in the row with the TC CBRN number on the approval label (paper) located in the UI. Each SCBA manufacturer has a unique part number for this approval label (paper insert label) and it is normally located in the lower right corner of the label. Part numbers that are found in the rows of non-CBRN approvals must not be used as part of a CBRN SCBA assembly.**

- ***USE THE PAPER LABEL TO PREVENT MISMATCH OF PARTS.*** **Some manufacturers separate all the CBRN part numbers on a given matrix and others do not. If the non-CBRN part numbers and the CBRN part numbers are inadvertently mixed and attached to SCBA hardware, the use of incorrect parts may cause death or injury. Administratively and legally, this action voids the NIOSH original approval for that TC number. Many emergency responders may not actually ever see the NIOSH approval label that comes with the CBRN SCBA due to oversight or misplacement of the insert.**

Figure XX. Back frame assembly with CDC and NIOSH CBRN Agent Approved Label located in the middle with a NIOSH abbreviated harness adhesive label at the top and NFPA 1981-SEI compliance adhesive label at the bottom. All three labels are required for NIOSH-approved CBRN rating compliance.

2. C. USER INSTRUCTIONS (UI)

Manufacturer's user's instructions describe procedures such as donning, fit, fit testing, unit assembly, pre-checks for leakage, breathing air cylinder inspection and exchange, doffing, maintenance, cleaning, storage, and preparation for disposal. In all cases, the manufacturer's user's instructions should be followed in accordance with local OSHA requirements and lead federal agency jurisdiction protocol.

User instructions specific to each CBRN SCBA are developed by the manufacturer for each unique model, reviewed by NIOSH for clarity and assigned a part number by the manufacturer. This part number and subject are required to be listed on the paper approval label found in the user's instructions. For the user, this NIOSH paper label is separate from the official electronic assembly matrix maintained by NIOSH.

2. D. SUBSCRIPTS 2 AND 3 ON THE NIOSH PAPER LABEL

The subscripts 2 and 3 on an assembly matrix label or a paper label refer to vital use information on the NIOSH CBRN SCBA approval label. Subscript 2 refers to the traditional NIOSH cautions and limitations associated with an industrial approved SCBA. Subscript 3 refers to special CBRN cautions and limitations applicable to the use of the SCBA under CBRN conditions.

NOTE: In all cases, all cautions and limitations must be strictly followed. Cautions and limitations I, J, M, N, O and S apply when non-CBRN conditions of use are present. Cautions and limitations Q, R, T and U are additionally applicable as well as I, J, M, N, O and S when CBRN agents are expected, known, or decontaminated.

2. E. NIOSH APPROVAL LIFE

The life of a NIOSH CBRN SCBA approval does not expire unless the production of the CBRN SCBA is suspended and the manufacturer notifies NIOSH that the product has been discontinued. NIOSH then performs a controlled quality assurance inspection and renders obsolete all relevant part numbers identified by the manufacturer from NIOSH records. The approval number for the obsolete respirator system still remains in the NIOSH database but the obsolete parts are no longer part of an approved assembly matrix.

2. F. RETROFIT/UPGRADE KITS CRITERIA

On March 11, 2003, NIOSH began accepting extension approval applications for the evaluation of components and procedures to upgrade previously deployed (field-deployed) NIOSH-approved self-contained breathing apparatus to CBRN-approved configurations. The purpose of the program is to test and evaluate retrofit kits used to upgrade field-deployed SCBA, to assure that upgraded SCBA comply with approved CBRN SCBA configurations, and to assure that the quality of the components and procedures used to upgrade previous versions of the SCBA establish the true CBRN-approved configuration. In addition to the NIOSH CBRN agent approved label, CBRN SCBA retrofit upgrade kits contain the replacement components, parts, materials, and operating instructions required to upgrade an existing SCBA configuration to the approved CBRN configuration.

A manufacturer's instruction manual will provide a list of these components, and the retrofit application will contain the following:

- The minimum technician qualifications for performing the retrofit, and the level of manufacturer training required
- A list of SCBA types certified for use with the CBRN approved retrofit kit
- Identification of the requirements for inspection and operational tests of the SCBA prior to performing the retrofit are required to verify that the SCBA complies with manufacturer quality and performance specifications for SCBA eligible to be retrofitted
- Detailed procedures for replacing components, parts, and materials required to establish the CBRN SCBA configuration
- Guidance concerning the CBRN SCBA operating instructions and differences from normal SCBA operating instructions
- Post retrofit inspections and tests required to verify that the work has been performed properly and that the CBRN SCBA operates in accordance with NIOSH, NFPA, and manufacturer requirements. As a minimum, the post retrofit inspection and test must verify leak tightness of assembly and components,

positive pressure (static face-piece pressure), exhalation resistance, by-pass function, remaining service life alarm operation, pressure gauge accuracy, and flow performance.

- Directions for installation of the NIOSH CBRN SCBA Retrofit Approval label

CBRN SCBA agent approved retrofit kits will contain a NIOSH CBRN agent approved (retrofit) label that must be affixed to the respirator after the upgrade is completed and the unit has passed the required post retrofit inspections and tests. If an SCBA retrofit kit is CBRN approved by NIOSH, it will be identified with a "NIOSH CBRN Agent Approved Retrofit" label. If the NIOSH CBRN agent approved retrofit label is not present, the retrofit kit is not approved.

NOTE: Check the NIOSH CBRN agent approved retrofit label to alleviate use errors! The following two figures on page 44 show the two possible types of NIOSH CBRN Agent Approved Retrofit adhesive labels likely to be encountered in the field. They both carry the same approval but vary by the presence of two logos versus one log. The second version that shows only the NIOSH logo and not the CDC Logo is the new version effective December 5, 2005. Both versions will be in the field until the older version, which has the CDC logo and the NIOSH logo together on the same label, is phased out.

Figure XX. SCBA CBRN Agent Approved (Retrofit) Adhesive Label.

Figure XX, NIOSH only logo label for CBRN Agent Approved Retrofitted SCBA, effective December 5, 2005.

2. G. UNIQUE CBRN MARKINGS

CBRN SCBA may have unique markings for production models which are designed by the manufacturer. These unique markings, if present, are not required for NIOSH CBRN SCBA approval, but tell the user that CBRN tested components are installed on the CBRN SCBA and make them easily identified in the field or when stored along-side non-CBRN SCBA.

Some examples of these markings are significantly re-designed facepieces, color-coded adhesive labels on the regulator, or other components of the SCBA, with the printed letters *CBRN* on them. Some components may be embossed with the letters *CBRN* graphically printed. Other components may have the letters *CBRN* etched in specific visible components of the SCBA.

2. H. UNIQUE ADMINISTRATIVE WARNING LABELS

CBRN SCBA have unique administrative labels provided by the manufacturer on the SCBA or in various forms of literature that accompany the SCBA. These unique labels provide written warnings, cautions, and informational statements on such topics that include, but are not limited to:

- Indications of damage which would require a cylinder to be removed from service
- Training requirements for use
- Inspection
- Maintenance
- Cylinder storage pressure, if the SCBA is out of service
- Recharging (filling) instructions
- Approved state of use only when compressed air reservoir is fully charged with air meeting the requirements of the Compressed Gas Association specification G-7.1 for Type 1, Grade D air, or equivalent specifications
- Use of adequate skin protection when worn in gas or vapor environments that poison by dermal exposure
- In making renewals and repairs, parts identical with those furnished by the manufacturer under the pertinent approval shall be maintained
- Cautions to open valve slowly and to close valve after each use and when "out of air"
- Cylinders should never be allowed to be completely empty

2. H-1. Cautions and Limitations, Paragraph 2

The following NIOSH industrial cautions and limitations appear in Section 2 on the approval label paper insert and are identified by a superscript [2] font on the paper label.

I Contains electrical parts, which have not been evaluated as an ignition source in flammable or explosive atmospheres by MSHA/NIOSH.

Note: *Caution and Limitation **'I'** will not be present on units which have met these evaluation requirements by MSHA/NIOSH.*

J Failure to properly use and maintain this product could result in injury or death.

M All approved respirators shall be selected, fitted, used, and maintained in accordance with MSHA, OSHA, and other applicable regulations.

N Never substitute, modify, add, or omit parts. Use only exact replacement parts in the configuration as specified by the manufacturer.

O Refer to user's instructions, and/or maintenance manuals for information on use and maintenance of these respirators.

S Special or critical user's instructions and/or specific limitations apply. Refer to user's instructions before donning.
Note: *Caution and Limitation **'S'** will only be on the NIOSH approval label if specified by the manufacturer in the user's instructions. When 'S' appears on the NIOSH approval label, the corresponding Cautions and Limitations, that apply under 'S', will be explained in a designated section of the manufacturer's user's instructions (UI)*

2. H-2. Cautions and Limitations, Paragraph 3

The following NIOSH cautions and limitations appear in Section 3 of the NIOSH approval label and apply specifically to use in CBRN environments. Cautions and limitations "**T**" and "**U**" deal with the limitations of use life in confirmed chemical warfare agent environments and determine the CRUL.

Q Use in conjunction with personal protective ensembles that provide appropriate levels of protection against dermal hazards

R Some CBRN agents may not present immediate effects from exposure, but can result in delayed impairment, illness, or death

T Direct contact with CBRN agents requires proper handling of the SCBA after each use and between multiple entries during the same use. Decontamination and disposal procedures must be followed. If contaminated with liquid chemical warfare agents, dispose of the SCBA after decontamination

U The respirator should not be used beyond 6 hours after initial exposure to chemical warfare agents to avoid possibility of agent permeation

2. I. MANUFACTURER'S WARNING STATEMENTS

The manufacturer's UI for each new SCBA may specify unique warning and caution statements specific to each model or type. Examples of such statements are instructions related to "air-hatch way" type second stage regulators and "manual slide/push-in" type second stage regulators. Compact demand valves marketed to law enforcement responders are not NIOSH CBRN approved. The respirator training program should include instruction on understanding the manufacturer specific warning and caution statements.

2. J. DEFAULT TO USER INSTRUCTIONS

The manufacturer's UI are specific for each CBRN SCBA production model. Users should rely on the OSHA regulations with NIOSH recommendations and the manufacturer's UI as the best source of safety and use information for their CBRN SCBA. Users should also contact the manufacturer with specific questions if their concerns are not addressed in the UI.

2. K. INDICATORS OF CHEMICAL AGENT PENETRATION

Indicators of agent penetration and permeation are recorded at the NIOSH level through the use of graphs and raw data per NIOSH task number. Below are two generic examples of the type of graph output recorded by NIOSH. Table X-3 depicts maximum peak values over time. Table X-4 depicts concentration over time (Ct) values. Both are required test results for each agent trial on an SCBA. Tabel X-3, the maximum peak LAT graph, shows GB pentetration of a SCBA breathing zone and how a low level concentration of GB continues to stay in the breathing zone for the duration of the six-hour test. A failing value for a maximum peak is 0.087 mg/m3 or greater. If a respirator gets three consecutive maximum peaks per trial, above or at 0.087 mg/m3, it fails the maximum peak requirement and therefore fails the trial. Table X-4 shows increasing cumulative concentrations over time in the breathing zones. The SCBA fails if it has a Ct value of 2.1 mg-min/m3 or greater at the end of six hours. If an SCBA fails either the max peak or the Ct criteria, it fails the entire test.

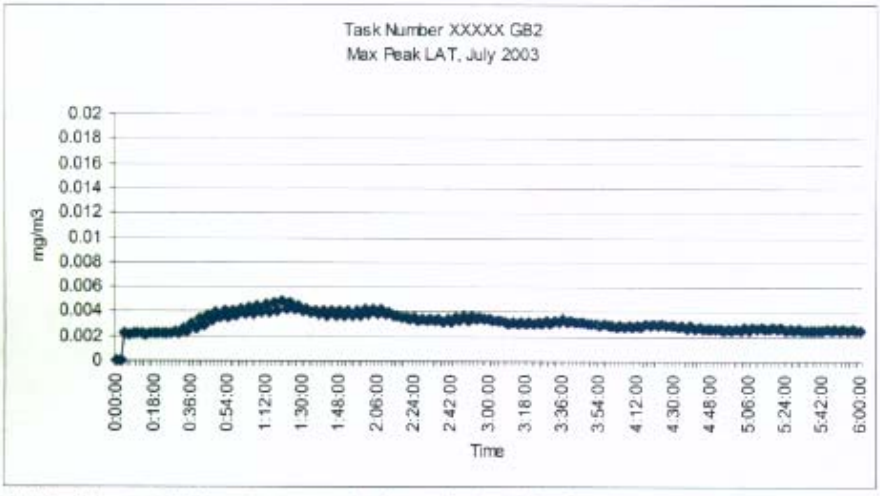


Table 3: Max peak GB live agent test result for certification of task number XXXX

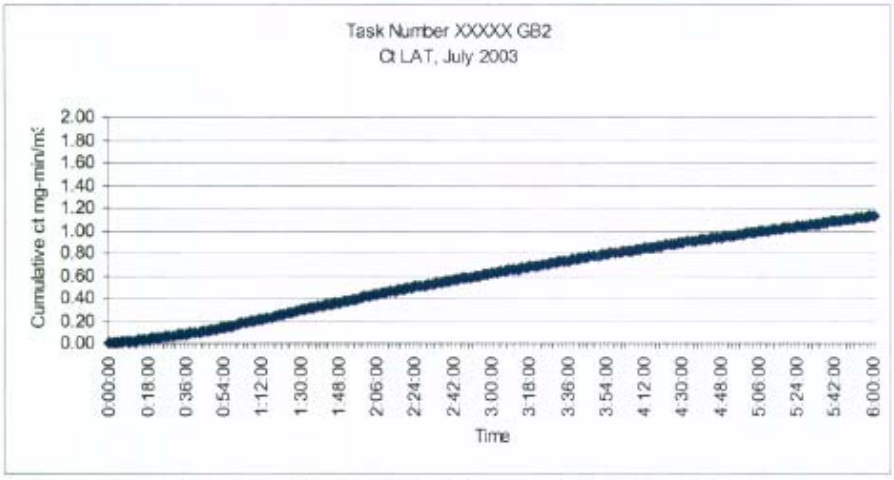


Table 4: Concentration over time (Ct) LAT test result for certification of TN XXXX.

Chapter 3: CBRN RESPIRATOR USE LIFE (CRUL) and SERVICE LIFE

3. A. SCBA CBRN RESPIRATOR USE LIFE (CRUL) CONCEPT

INTENT. A NIOSH CBRN SCBA has a six-hour (6) use life when exposed to chemical warfare agents. NIOSH/ NPPTL define CBRN respirator life (CRUL) as "*A specific recommended actual in-use life time value, in hours or minutes, distinct for a type of CBRN respirator.*" The understanding and implementation of this time value is contingent upon the user understanding and adhering to NIOSH approved cautions and limitations issued at the time of the CBRN respirator approval. The use life time value incorporates a continuous use life beginning at the time of confirmed chemical warfare agent exposure or contamination. This time **does not include** a variable time value that will be incurred as a result of disposing the CBRN respirator after its actual in-use life has expired.

LAT. The SCBA CBRN respirator use life concept is centered on a specific time value (X hours) generated from NIOSH scientific data that repeatedly shows passing test criteria and results for the safe operation of the SCBA under strict laboratory exposures against GB (Sarin) and HD (Blister) chemical warfare agents at the specified NIOSH standard test procedure time requirement. The CBRN respirator use life definition does not apply to respirator exposures against compounds or particulates that currently have NIOSH technical service life guidance in place, such as airborne particulates, provided the exposures do not degrade the air-pressure boundary or cause material surfaces of the CBRN SCBA to catastrophically destruct. If the unknown concentrations do cause the CBRN SCBA air-pressure boundaries or material surfaces to fail, the responder should egress to cleaner air, decontaminate, and doff the respirator per standard operating procedures.

CWA DETECTION. The availability of confirmed CWA contamination data is the key to determining the CBRN SCBA six-hour start point of a CRUL concept. Therefore, instruments designed to detect contamination at stated concentration levels are required to be at the incident site. Once detection confirms the agent type and quantity present, the CBRN SCBA actual in-use life of six hours begins.

***NOTE:* The six-hour use life means use is for six continuous elapsed hours in a single shift, day, or event. It does not mean six individual one-hour exposures in one shift or one day, nor does it mean six different one-hour exposures, over the course of six different days. The CRUL value applies to the SCBA system hardware and the cylinder neck valve assembly of the SCBA. Actual in - use life of the DOT exempted breathing gas cylinder/air cylinder, minus the cylinder neck valve assembly, is determined by on site observations.**

3.B. RATIONALE FOR CRUL

CBRN SCBA contaminated with chemical warfare agent are not expected to provide safe protection levels to users if used beyond the NIOSH six-hour recommended use-life limitation "U". The rationale for the six-hour use life limitation was developed from laboratory tests that evaluated penetration and permeation resistance of complete operating CBRN SCBA systems to GB and HD vapors and direct contact HD liquid droplets. The

six hours of testing require a tested SCBA to be refreshed with clean air essentially five times during one six hour test trial.

AEGL VALUES. Acute exposure guideline 2 (AEGL 2), at the one hour level, is used as the maximum breakthrough criteria with a safety factor added. GB AEGL 2 at 60 minutes is 0.0060 ppm. AEGL values are ranked from lowest to highest as 1, 2 and 3 and for 10 minutes, 30 minutes, 60 minutes, 4-hours and 8-hours. AEGL 1 values cause discomfort and are non-disabling. AEGL 2 values cause irreversible or other serious, long lasting effects or impaired ability to escape. AEGL 3 values are life-threatening effects or death. All AEGL values are in ppm unit of measure. See NIOSH Emergency Response Cards and EPA AEGL data for further information.

NAS, EPA and NRC. AEGL are established by a National Advisory Committee for the Environmental Protection Agency and the National Research Council. They represent threshold emergency exposure limits for the general population, including more susceptible segments of the population, and are applicable to emergency planning and decision making. The AEGL values are agreed upon by the public, other NIOSH scientists, DoD scientists and members of the National Academy of Sciences through a process of rigorous scientific discussion, consensus, and subsequent review.

AEGL 2 Value.is Baseline. Maximum peak concentrations identified in the test results are evaluated against AEGL level 2, 10-minute levels. AEGL values or levels address various degrees of toxic severity effects. Each of these levels represents the lowest estimate of a concentration above which a specified effect might be observed in an exposed population. AEGL level 2 values are the most appropriate threshold exposure limit (breakthrough) values for GB and HD testing since they ensure that no significant respiratory impairment or long-lasting effects will result if approved respirator systems are properly worn [Niemeier, Richard, NIOSH, 2001]. For example, peak concentrations, as measured in the test protocol for a passing SCBA, are not expected to exceed the 10-minute level AEGL 2 value during the duration of the six hour test. [Niemeier, Richard, NIOSH, 2001]. NIOSH/NPPTL adopted these values in defining the performance standard for the CBRN SCBA.

DURATION OF LAT. The duration of each agent test is six hours. NIOSH uses six hours because the most credible event time frame was determined by a joint NIOSH/RDECOM threat analysis as six hours plus or minus one hour. The analysis is not based on a worst case threat, but on a "most likely to occur" or credible event terrorist chemical warfare agent concentration gradient being dispersed during the six hours. Occasionally, this credible event concept is misinterpreted as a worst case scenario. A NIOSH toxicology safety formula is used to define the required level of protection the SCBA must be capable of providing. When GB is the test agent, the six test hours consist of 30-minutes of actual live agent contamination followed by 5.5 hours of natural decay of the GB due to a cyclic breathing pattern over time.

CYLINDER SERVICE LIFE IMPACT. Due to the service life capacity of SCBA air cylinders being less than one hour, or approximately 30 to 45 minutes, depending on the physiology and work rate of the wearer, the overall one-time exposure of personnel and SCBA equipment to CBRN agents is also expected to be less than one hour. However, responses at the Pentagon site in 2001 showed the same SCBA being used with the same or different cylinder for a maximum of 12 hours per terrorism response shift [Arlington County After Action Report (AAR), July 2002]. In Arlington County, SCBA were in short supply. Responders going off shift did not want to surrender their SCBA to other users coming on scene and had concerns about the potential for

contracting communicable diseases from sharing respirators. Air sources were in short supply and responders had to spend time looking for air replenishment. When air sources were available the use of quick charge and cylinder replacement were employed [Arlington County AAR, 2001]. These examples show that the same SCBA can be used for a longer periods than anticipated. The NIOSH goal was to identify existing SCBA respirators that provide maximum physical and chemical protection over a span of six hours. The establishment of a six-hour CRUL time value has achieved that initial goal. Only actual response(s) to a real CBRN incident will determine if the CRUL time value(s) are adequate.

GB and HD LAT CONCENTRATIONS RELATION TO CRUL: Both GB and HD are considered to be extremely hazardous agents given their toxicity, their permeation and penetration characteristics, their relative ease to produce, and their worldwide availability in thousands of metric tons when compared to toxic industrial chemicals.

HD LAT. The test parameters for the HD test are the application of a maximum of 43, 20-ul liquid droplets initially and then left undisturbed for the entire 360-minute (six-hour) test duration. Immediately after the drops are applied HD agent vapor concentration of 300 mg/m^3 is generated during the initial 30 minutes of the six-hour test. HD was selected because of its permeation characteristics. HD is a linear molecule that permeates surfaces over time and interacts at the molecular level to stay bonded to the material. Ideally suited to contaminate terrain, equipment, and cause delayed but prolonged affects on personnel, HD is considered to be a persistent classic chemical warfare agent by the U.S. military.

A combination liquid/vapor test is used for the HD. Liquid droplets of HD are placed on selected areas of the SCBA and a vapor challenge of HD is introduced into the test chamber. The liquid droplets and vapor contaminants test the permeation resistance of the respirator materials and the integrity of the materials to withstand the persistent chemical effects of HD. The permeation effects of HD are essentially non-reversible. HD contamination remains at the molecular level and RDECOM laboratory operations prove that decontamination using high temperature water baths force HD out of material surfaces but do not force out all of the HD (4 hours to upwards of 72 hours or greater). Once a material exposed to a chemical warfare agent is decontaminated to what is termed the "3X/XXX level", it is acceptable for disposal and incineration as a hazardous waste at a waste site collection point [RDECOM Protective Equipment Team IOP No. 12, March 2004].

GB LAT. The test parameters for the GB concentration are 2,000 mg/m3 of vapor/aerosol generated for the initial 30 minutes of the six-hour test. GB was selected because it is the most volatile of the nerve agents having a volatility of 22,000 mg/m^3, low molecular weight and a molecular branched configuration (approximately 108 angstroms in length), enabling it to permeate through SCBA materials more readily than other G series or V series nerve agents. Scientific studies on dogs and rats indicate that exposures to 0.001mg GB/ m^3 for up to six hours per day are unlikely to produce any signs of toxicity. For NIOSH respirator testing purposes, GB is representative of all nerve agents. Other nerve agents include GA (Tabun), GD (Soman) and VX. GB molecular configuration of approximately 108 angstroms enables it to penetrate surface interfaces, seams, openings, crevices, overlaps, or dead spaces of SCBA materials. A liquid GB droplet test is not performed by NIOSH since GB is understood to be the most significant threat when aerosolized rather than in a liquid physical state. GB liquid evaporates at a rate similar to water and therefore presents a non-persistent, but highly toxic hazard, which in a confined space requires both dermal and respiratory personal protection.

Therefore, the GB vapor adsorbed on the surface of the SCBA is also a dual source of agent exposure (dermal and respiratory) if not properly contained.

3. B-1. TIME

Occupational safety and health requirements for emergency responders exposed to CBRN agents are expected to vary depending on several factors. These factors have one dimension in common: Time. They are all directly or indirectly related around available time.

The ten related time factors are:

- **WEAPON-*Time and type of CBRN weapon employed*:** CBRN aerial spray, bomblets, liter containers, 55 gallon drums, postal envelopes, packaged boxes, rail line cars, bulk food containers, vehicle borne improvised explosive devices, or satchel improvised chemical devices employed independently, sequentially or simultaneously all rely on a timed detonator initiated by a terrorist.

- **WEATHER-*Weather conditions and target geography at time of employment*:** Variable factors such as changing air stability categories, before-morning-nautical-twilight weather conditions (BMNT), early-evening-nautical-twilight conditions (EENT), temperature gradients in air strata, wind speed at the surface and above ground, wind direction, daylight hours, nighttime hours, confined spaces, subterranean spaces, and urban, forested, inland or coastal regions.

- **TARGET AREA-*Density of structures in targeted areas contributes to how long a time the agent persists*:** Channeling effects of downwind hazard, open terrain, urban terrain, no structures, minimal structures, congested structures, low profile structures, high profile structures, evacuation routes in place, and shelter in place actions rehearsed and available to the public

- **TYPE OF TARGET-*Construction integrity of targeted structures contributes to how long an agent persists in a confined space*:** Soft target, hard target, reinforced concrete command post, public restaurant, public venue, public transportation, mobile target, and static target

- **AGENT CONCENTRATION-*Concentration of CBRN agents deployed contributes to length of time responders must stay protected*:** Low level dispersion devices, high yield dispersion devices, liquid pools, dissipating vapors, vapor density, physical constants of agents, and multiple targets

- **DETECTION/SAMPLING METHODS-*In place and adequate sampling and detection plans and the turn-around time it takes to have results:*** Remote sensing devices, on-site detection devices, chain of custody of samples, public health laboratory capacities, and federal laboratory turn around capabilities

- **TYPES OF PPE-*How the successful use of personal protective equipment contributes to the amount of time required to respond, assess, decon and recover:*** Selection, availability, serviceability and interchangeability of personal protective equipment

- **TRAINING-*Training and the time it takes to sufficiently train responders to awareness and technical levels of CBRN defense***: Psychological preparation, PPE training levels, onsite hip pocket refresher training and PPE acclimatization time for responders

- **LEADERSHIP-*Command and control and the time it takes to maintain effective leadership under duress:*** Timely characterization of the crime/accident scene, size up, scene control, stages of response

- **SECURITY-*Site security and the time it takes to evacuate, control the hazards, plot the hazards, and contain:*** Local population control, public relations, staging areas, evacuation, shelters, egress routes and methods, by-product disasters, timely mitigation, containment or disarmament of any secondary or tertiary CBRN device, evidence preservation, security of the scene, weapon/improvised device location, and robotics

All of these factors have one concept in common: time. Whether it is CBRN agent employment time, responder response time, available responder rescue time, responder air cylinder service time, or responder egress and recovery time, time management principles play a critical role in the success or failure of a response.

Three time-related processes governing the use life of the CBRN SCBA are 1) service life 2) rated service time 3) CBRN respirator use life.

3. C. SERVICE LIFE

The definition of the time process known as service life has precedence. A NIOSH definition of 'Service Life' for a SCBA is the "*period of time, as determined by NIOSH certification tests, in which adequate breathing gas is supplied.*" [DHHS (NIOSH) Pub No. 2005-100. 2004] This same definition applies to the 42 CFR 84 use of the terms 'rated service time' or "service time" [42 CFR 84, Para 84.70, (a), (b), (2) (ii), Para 84.95, (a), (b), (c) and Para 84.53, (a), (b).1995].

For the purposes of CBRN SCBA, service life is still the same industrial definition but with enhanced tactical use requirements. This inference is situation dependent but may refer to the length of time the system as a whole or its individual components (for example, facepiece, harness assembly, or regulators) are expected to remain functional based on time of use, exposure duration, exposure type, or number of uses. If the SCBA is exposed to vapor or liquid chemical warfare agents, the interim guidance related to CBRN respirator use life (CRUL) applies.

The SCBA manufacturer may specify service life information for the system as a whole or for particular components in the manufacturer's UI. However, industrial service life/time is commonly understood to be the 30, 45, 60 minute duration of cylinder capacity at specified pressure ranges. When specific service life information related to CBRN use or traditional industrial/fire use is available from the manufacturer, it should be followed. To ensure all components are functional and free from damage and excess wear, an inspection of all SCBA components should be performed prior to the beginning of each shift or as the user deems appropriate and in accordance with the manufacturer's UI. In making renewals and repairs, parts identical with those furnished by the manufacturer under the pertinent approval, shall be maintained.

3.C. 1. Service Life of Air Cylinder

The service life of an air cylinder is the length of time the cylinder can remain functional before it must be removed from service and permanently retired. How old is it? All manufacturers' guidance on cylinder service life is provided in the manufacturer's UI or is available from the cylinder manufacturer.

The U.S. Department of Transportation (DOT) Title 49 specifies regulations for marking, hydrostatic testing at the time of manufacture, and requalification of cylinders at specific time intervals depending on the design type of the cylinder. Requalification of cylinders can only be legally performed at retest facilities that have been issued retest identification numbers by DOT. The re-qualification of cylinders requires an internal and visual inspection, a hydrostatic test, marking or labeling, and maintenance of proper records of the re-qualification.

Re-qualification of SCBA cylinders is required with a predetermined frequency, depending on the design type of cylinder. Generally, composite cylinders, or those having a metal core wrapped in non-metal materials such as Kevlar or fiberglass composites, are re-qualified every three years and all-metal cylinders are re-qualified every five years.

The manufacturer or cylinder owner and retest facility are required by DOT to know how often to have the re-qualification performed. DOT-compliant, carbon composite cylinders have a maximum service life of about 15 years, as specified by the exemption issued to the cylinder, and are to be re-qualified every five years, as specified by the DOT exemption issued to the cylinder manufacturer. The service life of all-metal cylinders is determined at the time of re-qualification. If the cylinder passes the re-qualification, it can be used until the cylinder shows external damage, its next re-qualification or its end of service life. Select cylinder manufacturers that have longer than 15 year service life exemptions, such as 30-year, for carbon composite cylinders, should be contacted for relevant information regarding re-qualification.

Before each use of the respirator, the hydrostatic test date on the cylinder should be checked to ensure that it is current. Cylinders that are past due for DOT re-qualification should be immediately removed from service until they are re-qualified or have reached the end of their service life.

Damage and wear of cylinder components will affect cylinder service life. The cylinder assembly (cylinder, gauge, and valve) should be inspected before each use to ensure that it is functional. The NFPA 1852 *Standard on Selection, Care and Maintenance of Open-Circuit Self-Contained Breathing Apparatus (SCBA), 2002 edition*, contains recommended NFPA procedures for SCBA cylinder maintenance.

Cylinders should be examined for damage and wear before each use. Damaged cylinders must be immediately removed from service until adequately repaired. Signs of wear or damage that can affect service life are cylinder color change, burns, blistering, and deformities in the shape of the cylinder such as cracks, dents, weakened areas, and surface indications of penetrating chemical damage. Additionally, the manual rolling of cylinders on the floor to check for uniform cylindrical shape is a common practice in the firefighter workplace [Fire Department of New York City, 2004].

The criteria for conducting a visual inspection of the cylinders, including quantification of surface damage, are available upon request directly from the cylinder manufacturer or the SCBA manufacturer.

The respirator manufacturer can provide specific guidance on reading and interpreting DOT markings on cylinders and how the hydrostatic test date markings are updated when a cylinder is re-qualified. Among DOT marking requirements which users should be familiar with are the following three items:

- **Hydrostatic Test Date**
  The hydrostatic test date is the date the cylinder was hydrostatically tested and considered qualified for use. DOT also specifies regulations for the periodic requalification of cylinders. The hydrostatic test dates appear on each cylinder in compliance with applicable DOT regulations. It is generally specified by a month, a certification unique inspection symbol and a calendar year, i.e. 7^05, along with the issued RIN.

- **Cylinder Pressure Rating**
  Cylinder pressure rating is specified by the manufacturer to be either 2216 psig, 3000 psig or 4500 psig. The cylinder pressure rating on the cylinder must be checked against the manufacturer's UI and the SCBA in use, to ensure that it is compatible with the SCBA system. Under certain OSHA provisions interchangeability between similar pressure ratings but different SCBA manufacturer's air cylinders is possible on the incident scene.

- **DOT Exemption Number, Composite Cylinders/Specification Number, All-Metal**
  DOT exemption number or specification number corresponds to specific DOT regulations for cylinders, including retests and service life. All retesters, cylinder owners, and inspectors should be aware of any and all retest requirements and service life requirements pertaining to cylinders they handle.

3. C. 2. Service Life of Facepiece

All manufacturers' guidance on criteria for facepiece service life must be followed. The facepiece should be inspected before each use to ensure that it is functional.

Facepiece service life is affected by time, exposure event, operator maintenance, and number of uses. The elastomeric material of the facepiece must remain pliable to provide the best seal to the interface between the material and the pliable surfaces of the human face. Elastomeric materials of facepieces can become cracked, frayed, and lose elasticity over time. Cracks, tears, holes, or distortions of the facepiece may result from routine use or improper storage. Headstraps and head harness components should be replaced when broken, when elasticity is lost or diminished, or when excessively worn serrations on the head harness permit slippage. Broken and malfunctioning buckles should be replaced. Facepieces with cracked or badly scratched lens should be removed from service and repaired or disposed of properly.

Other components or accessories found on the facepiece which may need to be replaced or repaired are hydration devices, spectacle (glasses) inserts, heads-up display systems, speech diaphragms, and communication devices which electronically amplify the speaker's voice or send electrical sound transmissions. Hydration devices, also known as drink tubes, are not NIOSH-approved for CBRN SCBA or traditional SCBA. Next generation CBRN SCBA may incorporate hydration, ESLI, protective suit interfaces and other assorted technology enhancements.

3. C. 3. Service Life of Remaining SCBA Hardware

Remaining SCBA components which must be inspected prior to each use are the backframe and harness assembly, hoses, EOSTI, regulators, and system accessories. Damaged or malfunctioning hardware should be repaired or replaced by qualified personnel prior to use. Additionally, the SCBA manufacturer may specify service life information for specific components in the manufacturer's UI which should be followed when available.

3. C. 4. Rated Service Time Indicators

CBRN SCBA contain all the traditional NFPA compliant rated service time indicators and displays. The following three are the most prominent types:

- Heads-up display
- Pressure gauges
- End-of-service-time indicators

3. D. UNDERSTANDING THE NIOSH CAUTIONS AND LIMITATIONS

NIOSH CBRN caution and limitation 'U' listed on the NIOSH approval label contained in the manufacturer's user's instructions states:

> **3. D. 1. "U"-** *The respirator should not be used beyond six (6) hours after initial exposure to chemical warfare agents to avoid possibility of agent permeation.*
>
> This statement means that following use in an environment which contains confirmed chemical warfare agents, in liquid or vapor form, the NIOSH-approved CBRN SCBA must be removed from service and disposed of following 6 continuous hours of use after the initial confirmed exposure. The SCBA should not be reused and should be decontaminated and disposed of in a manner that is consistent with the type of contamination and any local, manufacturer recommended, or government regulations governing the decontamination and disposal of CBRN contaminated items.
>
> Confirmed CWA contamination presence is the key to determining the six-hour start point of contamination of a CBRN SCBA. Therefore, instruments designed to detect contamination at stated concentration levels are required to be on the incident site or made available. Once detection confirms the agent type and quantity present, the CBRN SCBA use life of six-hours begins. The CRUL six-hour time value means **six continuous hours** in a single shift, day, or event. It does not mean 6-individual one-hour exposures in one shift or one day, nor does it mean six different one hour exposures over the course of six different days. Six continuous hours stop at the five-hour, 59-minute and 60-second mark.

Respirator use beyond the six-hour mark of continuous use in a confirmed chemical warfare agent (CWA) incident goes against the NIOSH Caution and Limitation "U." However, in actual use the incident commander at the scene of a CWA incident may be confronted with the decision to implement use beyond the six- hour mark. For example, the need to rescue and recover victims, combined with a supply shortage of new CBRN SCBA units at the scene, could present such a need. Use of a contaminated CBRN SCBA beyond the six-hour mark may put responders at risk to possible exposure of CBRN agent, which could permeate the contaminated CBRN SCBA. The incident commander must determine at the six-hour mark if the possibility of agent permeation has been negated by immediate gross decontamination techniques.

Responders must also be aware of the possibility of indirect contamination by liquid or vapor CWAs which also are considered in the six-hour use life rule. Indirect contamination may occur, for example, when CBRN SCBA are used in downwind areas from the response site or a liquid CWA contacts a unit through direct or indirect contact with other responders, victims, or equipment outside of the target area. **The six-hour use life rule should be obeyed even if the SCBA is contaminated indirectly.** However, the incident commander may determine, based on the type and concentration of CWA exposure and immediate technical decontamination techniques, that modification to the six-hour use life rule is possible.

NIOSH CBRN caution and limitation 'T' listed on the NIOSH approval label contained in the manufacturer's user's instructions states:

3. D. 2. "T" - *Direct contact with CBRN agents require proper handling of the SCBA after each use and between multiple entries during the same use. Decontamination and disposal procedures must be followed. If contaminated with liquid chemical warfare agents, dispose of the SCBA after decontamination.*

In relation to the six-hour use life, this limitation states that if contaminated by a liquid chemical warfare agent, the SCBA should be disposed of after decontamination. The limitation warns against reuse after a liquid exposure due to the persistency of some CWA liquids; for example, HD is highly persistent as a liquid. In the case of a CWA liquid exposure, use beyond the six-hour limit is highly cautioned against even when rapid technical decontamination can be performed. Decontamination should be performed in all cases for all confirmed CWA exposures, even if the agent is considered non-persistent as a vapor (such as GB). Even non-persistent CWA vapors can permeate and remain in materials if exposure concentrations are high, such as in a confined space. CWAs can also become airborne in the form of liquid aerosols, which are small liquid particles and not in true vapor states. When the decision is made to eliminate the decontamination step from a response, levels of contamination may remain constant and continue to degrade material surfaces. Weathering of material surfaces may contribute to a level of natural decontamination.

NOTE: *NIOSH Interim Recommendations for Firefighters and Other First Responders for the Selection and Use of Protective Clothing and Respirators Against Biological Agents,* DHHS (NIOSH) publication number 2002-109, states "***decontamination of protective equipment and clothing is an important precaution to make sure that any particles or contamination that might have settled on the outside of protective equipment are removed before taking off gear. Decontamination sequences***

currently used by hazardous materials teams should be appropriate for the level of protection employed. Equipment can be decontaminated using soap and water as part of a removal process, and 0.5% hypochlorite solution (one part household bleach to 10-parts clean water) can be used as appropriate and if gear has any visible CBRN contamination. Note that bleach may damage some types of equipment. After doffing all PPE, emergency response workers should shower in safe non-contaminated area using copious quantities of soap."

Chapter 4: BEFORE, DURING AND AFTER USE ACTIONS

4.A. BEFORE USE

4. A-1. Shipping

CBRN SCBA should be shipped in the original manufacturer packaging. Routine DOT hazardous material labeling for filled air cylinders is required. Special care should be given to ensure that excessive abuse of shipped containers does not occur. Part numbers on the original invoice should match CBRN SCBA part numbers of the shipped order.

4. A-2. Receiving

Upon receiving a new CBRN SCBA, thoroughly check that all components and accessories are included in the shipment, the user's instructions are present, the NIOSH CBRN SCBA adhesive label is on the harness assembly and the NIOSH CBRN SCBA approval label paper insert is present in the UI. Match the individual component part numbers to the numbers listed in the respirator component column of the NIOSH approval label (paper). NFPA 1852 requires baseline posi-check of the SCBA upon receipt. A copy of the manufacturer's posi-check results should be provided with the SCBA. Ensure that you know how to read it and forward any questions or noted errors to the respirator manufacturer.

4. A-3. Inspection, Maintenance and Storage

This section provides guidance for the inspection, maintenance, and storage of CBRN SCBA. Users should **always** follow the manufacturer's suggested practices for inspection, maintenance, and storage of their individual CBRN SCBA model. A recommended reference is NFPA 1852 *Standard on Selection, Care, and Maintenance of Open-Circuit Self-Contained Breathing Apparatus (SCBA),* 2002 *Edition.*

4. A-4. Inspection

General Criteria: It is critical that the user verify that all of the CBRN SCBA components listed on the NIOSH approval label (that is the matrix style paper insert) provided with the user's instructions are present, correctly installed, and free from visible deterioration, wear, and damage. All guidance and recommendations made by the manufacturer should be followed.

Specific Criteria: The following inspection procedures should be performed before each use of the CBRN SCBA. The inspection sequence is per the manufacturer's UI and the listing may not be all inclusive.

Facepiece

- Check the elastomeric material for pliability, damage, tears, and cracks. Ensure that no material defects are present

- Check that all head harness straps are fully extended, functional, elasticity is not lost, buckles properly function, and buckles or straps are not damaged. Ensure that the types of head harness, Kevlar or butyl, and the visible part number for the head harness match the CBRN SCBA label by part number and material. The part numbers should be aligned with the applicable NIOSH TC number. If the part numbers do not match, contact the manufacturer. Ensure that a part number listed with the correct CBRN TC number is used- if it is not, the NIOSH CBRN approval is void.

- ***NOTE:*** **If the part number listed on the matrix for CBRN configuration does not match the part number located on the actual part, DO NOT USE THE RESPIRATOR FOR A CBRN RESPONSE.**

- Check the lens for holes, cracks, scratches, heat-damaged areas, and a properly maintained locking ring and seal with the facepiece material

- Check the second stage regulator exhalation holes or valve for debris that, if present, could inhibit proper regulator seating/sealing and locking of the regulator to the facepiece assembly

- Check the regulator connection(s) for damage and proper function. If an air hatch is attached, ensure it is free of debris and slides up and down easily.

- Check that the heads-up display, if present, is functioning properly

Backframe

- Check that harness straps and backframe are free from cuts, tears, abrasions, and indications of heat and chemical-related damage. Ensure that the NIOSH CBRN label and harness assembly label are present and readable.

- Buckles and fasteners should be checked for proper adjustment. Fully extend the harness straps

- The cylinder retention system should be checked for damage and proper operation and to ensure that the cylinder is securely attached to the backframe

Cylinder Assembly (cylinder, gauge, and valve)

- Check that the hydrostatic test date on the cylinder is current. Cylinders that are past due for DOT requalification should be immediately removed from service until they are re-qualified

- Check the cylinder body for cracks, dents, weakened areas, indications of heat damage, discoloration and indications of chemical damage

- Check the cylinder valve outlet sealing surface and threads for damage, wear and clear any debris found

- Check the valve hand wheel for damage, proper alignment, and secure attachment

- Check the burst disc outlet area for debris and ensure that it is clear

- Check that the cylinder is fully charged to the manufacturer's specified pressure rating. Air cylinders should be maintained in a fully charged state but should not exceed the manufacturer's maximum

recommended pressure. Air cylinders should be recharged when the pressure falls below one quarter of the manufacturer's recommended full pressure level. Use the local department standard operations procedure (SOP), respirator manufacturers UI, applicable NFPA codes and OSHA regulations.

- If the user is technically qualified, he or she should ensure that the neck cylinder valve assembly is fully serviceable and shows no bends in the neck valve or probe. Ensure that the burst disc is clean and lubricated per the UI. Ensure that the independent air pressure gauge internal to the neck cylinder valve is readable and showing proper air pressure when correctly torqued into the cylinder. If the user is not technically trained and qualified to conduct these checks, refer these actions to the highest level of maintenance.
- DO NOT DROP the assembled CBRN SCBA on the high pressure hose coupling adjacent to the neck cylinder valve assembly
- Dropping the SCBA from high elevations may produce a damaged CBRN SCBA. All maintenance should only be done by a team or individual trained and certified by the CBRN SCBA manufacturer and in accordance with applicable standards such as the NFPA 1404 code.

End-of-Service-Time Indicator (EOSTI)

- Check that all EOSTIs function and work in accordance with the manufacturer's instructions
- The inspection should ensure that the alarms function properly by observing visual, audible, or vibrating signals over a period of time as specified in the user's instructions

Regulator

- Check the regulator controls, where present, for proper function. Ensure thatall CBRN markings are readable and that unique CBRN components are in place per the UI.
- Listen for any unusual sounds such as whistling, chattering, clicking, or rattling during operation
- Check that the regulator by-pass functions properly. Use the by-pass and check for correct de-pressurization/bleed down

Pressure Gauge

- Check that pressure gauges are functional and that the cylinder pressure gauge and remote gauges read within 10% of each other. The remote pressure gauge can be a mechanical gauge face or a visual signal continuously displayed as part of a facepiece HUD
- Ensure that any vent holes are free of debris prior to activation

PASS (Personal Alert Safety System) Device

- Check all operating modes for proper function in accordance with the manufacturer's UI

- Ensure batteries are available and installed for operation per UI

Final Pressure Check

- As the final inspection item, the entire CBRN SCBA should be checked for pressure retention. This is accomplished by closing all regulator valves, opening the cylinder valve, thereby pressurizing the CBRN SCBA, and then closing the cylinder valve
- The system should hold pressure in accordance with the manufacturer's specifications after the cylinder valve is closed. Ensure the length of time is as stated in the UI. Reopen the valve and observe gauge changes for proper movement and stability.
- Following the pressure check, the system pressure should be released per the UI

4. A-5. Maintenance

All maintenance, repairs, and replacement of parts on a CBRN SCBA are required to be done by trained and qualified personnel. Following any maintenance procedures, a qualified person should verify that the SCBA has been assembled to the correct NIOSH approved CBRN configuration, which is printed on the NIOSH CBRN SCBA approval label paper insert of the user's instructions. All maintenance is done in accordance with the manufacturer's user's instructions, local departmental SOP and recognized training with the manufacturer's representative.

4. A-6. Storage

- Respirators required to be immediately available should be stored in a ready-to-use condition. This condition is normally manufacturer and departmental specific but overall, it is designed to protect respirators from excessive dust, excessive radiant sunlight, excessive heat transfer, incompatible damaging chemicals, or excessive cold and moisture, and other conditions as specified in the UI.
- Facepieces and second stage regulators should be stored in normal use positions, if possible. Impaired functions of the facepiece or regulator may result if the facepiece elastomer is allowed to sit in an abnormal position, such as inside a turnout gear jacket, wedged in between a seat and seat storage area, stored where the head harness straps are inadvertently placed over the facepiece lens/visor or the facepiece is exposed to the natural elements of weather for an excessive amount of time.
- Respirators not used on a daily basis should still be maintained for immediate use in the event that responders need to replace a field-deployed respirator. Some user's instructions recommend storing the dried facepiece in clear plastic bags and placing them in storage cabinets. Contingency stocks stored for long periods in climate controlled facilities or designated warehouses should be inspected regularly in accordance with the CBRN SCBA manufacturer's UI.
- The OSHA respiratory protection standard [29 CFR 1910.134] allows for SCBA to be stored in vehicle compartments or in specific SCBA covers/containers/bags on fire trucks/law enforcement vehicles/ambulances. Brackets that are mounted on a wall or a stable surface, like a jump seat on a fire truck, are normally used to store SCBA. The brackets, when properly designed to a specific SCBA,

ensure that the SCBA is secured, covered and not subject to being wedged in a constricted space that would likely produce facepiece distortion or airline hose compression.

4. A. 7. RESPONSIBILITIES

Protection performance differences between CBRN SCBA and non-CBRN SCBA are significant, depending on the type of particular SCBA used. Respirator protection program administrators, incident safety officers, departmental health and safety officers or other similar duty personnel have unique use challenges when integrating CBRN SCBA into an existing respirator protection program or when starting a new respirator protection program.

While the CBRN SCBA retains many of the same respirator program qualities of the standard non-CBRN SCBA, new "use" challenges exist. They are the implementation of CBRN SCBA in-use service life protocols, integrating CBRN SCBA decontamination operations, understanding CBRN SCBA retrofit/upgrade kit instructions and requirements, and recognizing CBRN SCBA administrative label markings. User level exchange of non-CBRN SCBA and spare cylinders for NIOSH-approved CBRN SCBA and spare cylinders will require initial and refresher training relevant to the new aspects of how a responder department conducts a CBRN agent response.

"Mask division" or "Mask service unit" personnel of fire departments are best suited to fully integrate manufacturer-specific warnings, cautions, and alert messages pertaining to operation and maintenance of CBRN SCBA and upgraded CBRN SCBA. Additionally, local emergency responders may have manufacturer trained and certified technicians that manage SCBA maintenance programs at the law enforcement, emergency medical or hazardous material response levels.

It is likely that in emergency responder departments that replace old SCBA with new CBRN SCBA, both non-CBRN NFPA compliant SCBA and CBRN SCBA will be present for a period of time. In that case and in incident response cases, responders should be thoroughly trained on how to differentiate CBRN SCBA from non-CBRN SCBA. A few recommendations are as follows:

- CBRN approved components can only be used in NIOSH-approved configurations shown in the assembly matrix on the inside page or pages of the specific CBRN SCBA user's instructions
- The NIOSH-approved CBRN SCBA can be used only with a specific type of facepiece model number, for example, a Hycar material model number.

NOTE: Silicone facepieces or components, when used without butyl or Hycar second skin layers, have been shown to contribute to the failure of a respirator during NIOSH CBRN special test requirements.

- The NIOSH-approved CBRN SCBA usually has specific types of second stage air-pressure regulator assemblies. These regulators are part number specific to NIOSH-approved CBRN SCBA. They should not be intermixed with non-CBRN/industrial or non-CBRN/NFPA compliant SCBA.

4. A. 8. TRAINING

Qualified initial and refresher training on all aspects of the proper use, emergency use, use life and disposal of the CBRN SCBA are recommended for all CBRN SCBA users.

To attain the proper respirator fit, seal, and operational capability, users should be trained, retrained and confident in using a CBRN SCBA before an actual response event occurs. In a well defined respirator program users should know the UI thoroughly and practice donning, wearing and removing/doffing regularly to attain and maintain proficiency. Knowing the working state of the SCBA before a response will assist responders in gaining maximum use from the built in design qualities of a SCBA during a response.

SCBA training is intended to be administered through a complete respiratory protection program as described in OSHA, 29 CFR 1910.134. A complete respiratory protection program covers criteria for selecting respirators, medical evaluations, fit testing, maintenance, inspection, cleaning, storage, worker training, and frequent evaluation of the effectiveness of the program. The respiratory protection program is to be directed by a designated knowledgeable professional, commonly known as the respirator program officer/administrator (RPO).

Incident safety officers (ISO) and health and safety officers (HSO) play key roles in convincing responders that their safety is a priority on the worksite and that safety awareness and actions can minimize acute and potentially chronic workplace exposures. The respirator program administrator interacts with management and oversees all aspects of the respirator program. The RPO and the ISO/HSO should be available to the user for questions or concerns on respirator use, training programs available for acclimatization and proficiency.

The required training under the OSHA Respiratory Protection Standard [29 CFR 1910.134] includes:

- Why the respirator is necessary and how improper fit, usage, or maintenance can compromise the protection of the wearer offered by the respirator
- What the limitations and capabilities of the respirator are
- How to use the respirator effectively in emergency situations, including situations in which the respirator malfunctions
- How to inspect, put on and remove, use, and check the face seal of the respirator
- How to recognize medical signs and symptoms that may limit or prevent the effective use of respirators
- Information relating to the OSHA Respiratory Protection Standard [29 CFR 1910.134] is available at the OSHA Respiratory Protection website at: http://www.osha.gov/SLTC/etools/respiratory/index.html

4. A. 9. AIR SOURCES

- Compressed air supply sources for CBRN SCBA are identical to non-CBRN/industrial SCBA air sources. The quality of Grade D or higher air generated or stored in a source/vessel requires regular inspection.
- CBRN SCBA requires the same "grade of air" routinely used in fire fighting, law enforcement or industrial/non-CBRN SCBA workplace environments
- During NIOSH CBRN SCBA certification tests, certain SCBA show non-toxic particulates circulating in the air pressure boundary of the tested SCBA. In the course of NIOSH CBRN SCBA TDA-99M testing, CBRN SCBA can have particulates in the exhalation air flow of the operating SCBA. These particulates are thought to be oil, water, and other compounds that are off-gassing from the internal mechanisms of the SCBA. Manufacturers that have high particulate counts are required to provide Material Safety Data Sheets (MSDS) stating what the health impacts are from the off-gassing particulates, prior to receiving a NIOSH-approved letter.
- Before use in a CBRN incident response, air sources should at a minimum be fully compliant with all Compressed Gas Association (CGA) requirements for Grade D air.
- CBRN contamination of air sources during an incident response or attack is best prevented by locating the air sources away from contamination or shielding them in suitable containers/areas. If air sources become contaminated, quantify the contamination to ensure that the air source is contaminated, tag the source and locate/procure uncontaminated air sources for immediate or future operations.

  Note: Do not use an air cylinder that contains, or is suspected of containing contaminated air.
- Compressed 'gas'/air cylinders used with CBRN SCBA are DOT certified and exempted under current DOT provisions for shipment of hazardous cargo.

4. A. 10. DETECTION METHODOLOGIES

- Emergency responders may train on three types of CBRN incident detection methodologies before actually responding to a CBRN incident. The three types are as follows: training on the types of CBRN qualitative indicators, training on qualitative detection actions/kits and training on sampling and monitoring actions required for formal chain of custody quantitative detection methods.
- Knowing the type of hazards before arriving on scene should assist responders in decision logic pertaining to the type of PPE necessary. Characterization of a CBRN incident will be the most challenging aspect of a response.
- Indicators that a chemical agent attack has occurred:
  - Standing pools of unknown liquid on flora/fauna/manmade surfaces with no odor, mild odor, or strong odors;
  - Visible colored or gray colored aerosol clouds slowly moving or stagnate in low lying areas;

- Humans or animals in respiratory distress/confusion, prostrate humans or animals, or immobile humans or animals with excessive salivation, bodily excrement, or convulsions/SLUDGE symptoms;

- Examples of mild odor threshold smells for chemical warfare agents are as follows:

    - new-mown hay/cut lawn grass, green corn
    - faintly or overtly fruity smell
    - camphor
    - peach kernels
    - musty, damp dirt or basement smell
    - sugary sweet, shellac/varnish
    - bitter almonds
    - pungent acid like
    - mild to severe garlic, horseradish
    - soap
    - slightly geranium smell
    - alcohol and ammonia mixture
    - strong to light fish odor

Knowledge of odor threshold types or smells outlined may assist emergency responders in determining the presence of chemical agents before entry. The above odor threshold examples are not all inclusive and do not account for next generation weapons. Immediate recognition of these odors should cause all responders in the immediate area to don all available protective equipment-especially a CBRN SCBA.

- Preparing CBRN detection instrumentation at the departmental level requires proper maintenance, continual training and correct utilization of all available detection methodologies and instrumentation in the department and mutual aid agencies

- The detection of CBRN agents is the most difficult aspect of a CBRN incident response. Detection monitoring training and refresher training done before a response should contribute to a higher level of mission accomplishment during the response.

- Currently, CBRN agents are not easily detected with monitoring technology available to emergency responders. Most direct reading monitors or hand-held detectors/detection equipment have limited sensitivity and selectivity/detection capability. A simple "yes" or "no" to agent presence is likely all that is needed by initial first responders, however, depending on agent persistence on site, that answer may not be available.

    - **NOTE:** The monitoring limits of detection (LOD)/range of detection for the most common hand-held instruments are typically calibrated at higher ranges than the expected CBRN exposure levels capable of causing harm to emergency responders. In other words they will not detect agent presence until it is a concentration that already can cause severe harm to responders. This makes using the detection instrument feasible only when full Level A protective ensembles are worn and never used without wearing Level A for entry and Level B for zone transition areas.

- **NOTE:** Additionally, the lack of agent selectivity or the potential for response to interferences from fake agents, may prevent first responders and first receivers from making an accurate determination that a CBRN agent is present/positive; not present/negative; not present but detector reads that it is present/a false positive; or present but the detector reads it as not/a false negative.

  The existence and identity of the agent or agents is best determined by more specific monitoring technology, like that typically found in laboratory-based instrumentation at the county, state or federal public health or scientific research levels [Kennedy, Eugene: November, 2004].

- Available qualitative and quantitative detection instruments can be maintained and kept ready to assist in assessing gross CBRN agent presence at the response site. These instruments will also provide an indication of the presence of CBRN agents on personal protective equipment, including CBRN SCBA. However, the results from these instruments should not be used to determine "all clear" areas or to determine the absence of contamination on equipment or personnel, or to quantify the type of contamination present.

- Detection accuracy is paramount and therefore, sample collection operations should use highly reliable laboratory methods and a documented chain of custody. The health of responders and the potential discarding or saving of responder equipment will rely on the quality of laboratory methodologies used to determine the existence and identity of a CBRN agent.

- Examples of direct read instruments and kits available today are common military products such as the M256A1 kit, M-8 paper, M-9 tape, the chemical agent monitor (CAM), the improved chemical agent monitor (ICAM), the ICAD miniature chemical agent detector, ABC-M18A2 chemical agent detector kit, the M272 chemical agent water testing kit, and the APD-2000 CW agent detector. The list is not all inclusive.

- Examples of rapidly changing civilian products are developments in wireless gas detection, surface acoustic wave (SAW)-based CWA and TIC detectors, RAZOR™, field hardened biological agent detectors and multi-ion mobility spectrometer (Multi-IMS) CWA and TIC detectors. These hand-held direct reading instruments may contribute to assessing the local contamination presence and help establish initial zones of protection known as hot/red zone, warm/yellow zone and cold/green zone. However, the instruments are subject to interferents and inadequate lower levels of limits of detection. A laboratory qualified to make chemical agent identification should be used to determine the type and quality of CBRN agent present.

- Initial and follow on detection/monitoring qualitative and quantitative results are important in providing risk assessment criteria to the incident commander for determining the start time of in-use life for a CBRN SCBA and other relevant PPE.

- Pre-maintenance checks and operations are necessary before "use operations" start to ensure all available detection instruments are operational within manufacturer specifications and the instruments are pre-positioned to support ease of use.

- The necessity to confirm, by means of either qualitatively or quantitatively monitoring, the presence of chemical warfare agents is critical because without some form of detection, the incident commander must assume the "worst case" and consider all CBRN SCBA as contaminated from initial onset of incident response to a CBRN event. The practice may result in numerous CBRN SCBA respirators being discarded at the end of the first six-hour period, if detection measures are not fully qualified and implemented in support of hazard zone analysis, respirator selection and respirator use logic. Default timing concepts may be used if detection is not possible and may involve quarantine of suspected CBRN SCBA until monitoring results are available.

- NIOSH CBRN SCBA use life limitation of one total six-hour period following the initial confirmed exposure to a chemical warfare agent is highly variable if detection instruments are not used to identify that contamination is present.

4. A. 11. PREPARING FOR DECONTAMINATION

- Maximum and minimum decontamination layout diagrams are described in the DHHS (NIOSH) publication No. 85-115, entitled Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities NIOSH [1985]. Level A and B protection decon lay outs are a 19 step process and involve step-by-step station descriptions for each item of PPE removed. Decontamination of CBRN agents, specifically chemical warfare agents on an incident site is time sensitive. The faster the contaminating agent is removed the lower the exposure dosage and the higher the amount of run-off waste water/solution. Ladder truck spray decon is expedient, simple and pervasive, however it is not full technical decontamination. Decontamination will aid in lowering the levels of agent present. Lack of decontamination operations may cause increased risk to responders from agent transfer. In order to conduct decontamination operations during a CBRN incident response, proper training, decontamination methods and decontamination equipment should be done and procured in advance. Individual emergency responders will benefit from the use of immediate decontamination processes that help in removing gross CBRN contamination from PPE and other surfaces. A decontamination plan should be in place and appropriate skill levels decontamination training (awareness, technician etc.) should be part of a CBRN emergency response plan

- Currently, gross decontamination with plain water is the most common decontamination process in use by emergency responders- ladder truck decontamination.

- The use of disposable protective ensemble suits that encapsulate the responder and the CBRN SCBA may prevent contamination of the SCBA and thus reduce or negate the amount or need for decontamination provided monitoring and detection instrument results are valid and repetitive. This protective measure was effective in recent anthrax responses whereby the disposable ensemble was discarded while retaining the SCBA.

- Decontamination methods should be employed that address the particular CBRN agent type, **if known.** Decontamination processes, based on EPA adjusted bleach pH methods, have been demonstrated by the EPA as capable of providing upwards of six logs of kill effect for biological agents, after sufficient saturation time on porous or hard surfaces. This means that with the proper use of pH control measures, exponential logs of kill can be achieved by maintaining proper pH ranges of the decontamination solution.

Methodologies for decontamination of select chemical warfare agents, biological agents or toxic industrial compounds are formulated by the EPA [EPA, April 2005].

Note: Various bleach solutions may deteriorate or etch some SCBA harness materials and may not be detectable by the wearer at the time of deterioration [MSA, 2004].

For additional information regarding the adjusted bleach pH method of decontamination see the following links: http://ehp.niehs.nih.gov/members/1999/107p933-974munro/munro-3.html
http://www.epa.gov/etv/verification/testqa-index.html#bdt

- Depending on the suitability and availability of individual decontamination kits for emergency responders, emergency responders may benefit from having local individual decontamination kits, such as the M258A1 or M291 kits, available to remove spot CBRN contamination at the time of exposure
- Caustic solutions of decontaminates, while routinely available, will deteriorate CBRN SCBA and other PPE
- Decontaminated CBRN SCBA, as determined by field measurements, should be held in zoned staging areas until the decontamination efficacy is confirmed by qualified laboratory tests

4. A. 12. ELECTRONIC COMMUNICATIONS

- CBRN SCBA are approved with specific communications interface accessories. Before use operations should ensure that communications devices and accessories are mounted correctly and do not impede form, fit, or function of the CBRN SCBA.
- Before use the responder should test communications products on CBRN SCBA in accordance with local policies.

4. A. 13. EXTREME WEATHER CONDITIONS

- CBRN SCBA being prepared for use in extreme weather conditions should be maintained per the manufacturer user's instructions. Usually, SCBA user's instructions contain the minimum use temperatures for operating the SCBA. If the UI does not state this, contact the manufacturer. Application of anti-fog coatings to the interior of the lens may be required prior to use in a cold temperature environment.
- Extreme weather conditions, such as freezing temperatures, are not ideal conditions for CBRN agent employment. HD becomes solid at temperatures equal to or lower than 14.45 °C /54.5 °F [Department of Defense, January 2005 and NIOSH emergency response card for HD, 2005]. However, as the temperature increases, it is generally understood that HD contamination will create permeation and penetration hazards as it melts.
- Confined spaces may present high ambient temperature conditions. CBRN SCBA is designed to withstand appropriate high temperature exposures per NFPA 1981 compliance testing. Users should refer to NFPA

1981 or the appropriate user's instructions for temperature use ranges. All NIOSH CBRN SCBA have been tested at a relative humidity of 50 +/- 5% and a temperature range of 25 +/- 3 degrees C.

4. A. 14. MIXING OF NON-CBRN INDUSTRIAL, NON-CBRN NFPA, AND CBRN PARTS

Readiness operations such as equipment preparation, equipment load planning, and equipment re-supply, contribute to mission success. If parts of a CBRN SCBA are inadvertently mixed with any type of non-CBRN SCBA parts, NIOSH approval is voided. Death or severe injury could result from use of what is becoming known as a "mismatched SCBA." The CBRN SCBA approval is only maintained when the parts and accessories listed on the official NIOSH approval matrix maintained by NIOSH and the official NIOSH SCBA label issued with the manufacturer's user's instructions are used.

Mismatch of the SCBA will void the NIOSH approvals of both. Non-CBRN parts cannot be substituted for CBRN parts. Furthermore, a CBRN SCBA with substituted non-CBRN parts is not expected to provide the same level of protection as a correctly assembled CBRN SCBA using the specified parts in the approval matrix. Additionally, manufacturers use color-coded critical parts of a CBRN SCBA in an effort to prevent mismatching and contribute to ease of identification and reassembly.

4. A. 15. INTERCHANGEABLE COMPRESSED AIR CYLINDERS FOR CBRN SCBA

- NIOSH-approved CBRN SCBA is required to use specified compressed air cylinders/bottles as listed on the approval label
- Variations between NIOSH-approved CBRN cylinder neck valve assemblies and non-CBRN cylinder neck valve assemblies may exist for field deployed SCBA, however, with the advent of NIOSH CBRN SCBA marketing, those variations are slowly being eliminated due to the fact that most new cylinder neck valve assemblies are CBRN approved and manufacturers have chosen to make the CBRN neck cylinder part number standard on either an industrial SCBA or a CBRN SCBA [NFPA 1981 TG Interchangeability, 2005].
- Crisis response may force an incident commander to use different CBRN SCBA air cylinders/bottles on compatible air pressure range hardware. Similar air pressure duration cylinders from different manufacturers are not recommended for interchange between NIOSH CBRN SCBA. Their use will void the NIOSH CBRN approval and may cause a safety hazard, especially in the case of a field deployed, non-CBRN approved cylinder, fitted to a CBRN approved hardware system.
- The use of any prototype universal cylinders, such as a NFPA universal cylinder and valve assembly, is not NIOSH-approved and will void the approval of a NIOSH CBRN SCBA. As standards are updated to allow interchangeability of cylinders and cylinder neck valve assemblies, NIOSH approvals will adjust to support the best interest of the responder, manufacturers and legal mandates.

4. B. DURING USE OPERATIONS

4. B. 1. Donning

CBRN SCBA are expected to be put on or donned in clean or CBRN contaminate-free environments. CBRN contamination is itself unpredictable due to many variables. If, as a CBRN SCBA user, you are caught off-guard by a secondary or primary CBRN device explosion, spray, or other source of contamination, close your eyes, hold your breath and don the CBRN SCBA facepiece and regulator as quickly as possible. Do a user's seal check while still holding your eyes closed in case you have inadvertently trapped agent while donning the facepiece.

Use of the red by-pass valve to clear the respirator is also an option but contingent upon how much air is available. Placing the SCBA on your back should be a priority only after you have successfully donned and activated the CBRN SCBA. Use of the reduced profile maneuver in reverse, may allow enough time to protect the respiratory system from exposure. Resume normal SCBA wear posture once the situation is stable or if the requirement to evacuate the area is specified. A second person may need to provide the required assistance to effectively don the SCBA after the responder has already donned the facepiece expediently.

NOTE:

Each individually manufactured CBRN SCBA may have unique donning procedures required to be performed before or during donning.

Do not use a partially full cylinder for CBRN SCBA response. If the cylinder is not full, the service time is reduced accordingly.

The use of a lens cover on CBRN SCBA facepiece/visor may provide an additional layer of protection to the facepiece from scratches but also may catastrophically fail when exposed to HD, if not NIOSH-approved for CBRN protection. External lens covers that reduce sun glare should be checked for CBRN protection compliance before use.

Do not use the respirator if hissing or popping sounds are heard from the SCBA during donning/activation.

Pressure gauge readings should correspond correctly when all air leak checks are conducted. Any regulator seating rings not seated properly in grooves should be re-aligned. Air hatches should operate smoothly.

The planned use of an integrated PASS panic button could provide a standardized warning measure to fellow responders that a CBRN event has occurred on the site.

Ensure that you consult with the respirator manufacturer if any obvious or delayed performance indicators are not working properly before responding to an incident.

If the SCBA malfunctions during use, notify IC, seek air resupply and initiate egress actions as quickly as possible.

Recommend strict attention to readiness training conducted for CBRN SCBA use and frequent reading of the UI on a regular basis to ensure the familiarity of unique donning practices, such as turning an 'AIR KLIC' device counterclockwise to tighten it or ensuring an air hatch slide is debris free.

4. B. 2. Use

Actual use actions, after successful donning of the CBRN SCBA, are dictated by the type of incident response (CBRN, CBRNE, B-NICE, Explosive, TIC etc.).

If, during use the CBRN SCBA faceseal is broken, every effort should be made to escape the hazardous area. While escaping, immediately attempt to regain the facepiece seal by performing the manufacturer's facemask user seal/fit checks, or by other appropriate methods such as "purge-on," etc.

In CBRN contaminated environments, over pressure, also known as positive pressure, from the pressure-demand SCBA, may provide a level of protection, but CBRN certification tests have shown that a uniform, firm, face-to-facepiece seal is best in protecting the breathing zone during inhalation and exhalation.

Static pressure, which is the pressure in the facepiece at 0 psig flow while in use, can range between 0.0 to 1.5 inches of water pressure. A NIOSH-approved SCBA is designed to maintain positive pressure in the facepiece during the NIOSH breathing machine test at a ventilation rate of 40 liters per minute or 115 liters per minute at peak flow.

During the inhalation cycle of a breathing machine, the facepiece pressure can vary from 1.5 to 0.0 inches of water column pressure. Static air pressure in the breathing zone of a NIOSH-approved SCBA is less than 1 psig. It has an exact range of 0.0542 psig to 0.1265 psig or 1.5 inches to 3.5 inches of water pressure [NIOSH, 2001].

4. B. 3. Wearing

Wearing the SCBA may have different meanings to different types or levels of responders. It may mean having the SCBA harness on your back, with the facepiece in a standby hanging position on an equipment hook, or fully wearing the entire respirator with facepiece donned, per the applicable user's instructions.

4. B. 4. Using

Using the SCBA may mean having the facepiece donned and using air while the SCBA hardware is on one's back or in the reduced profile maneuver position. Reduced profile maneuver position is where the SCBA backframe and harness assembly are removed from the wearer's back but the facepiece is still donned and maintaining a seal. This maneuver is done to allow responders to fit through confined spaces as needed.

Contemporary examples of when SCBA are actually used have been discussed in numerous publications. However, actual specific use requirements for SCBA use are normally directed by local departmental

regulations. A search of relevant literature shows that generally, fire department responders use SCBA when performing the following actions:

- Interior structural firefighting operations to save lives
- Interior hazardous materials operations when toxic substances or smoke are present and all civilian personnel are evacuated
- Operating in outside conditions while being exposed to smoke or toxic substances downwind or upon entry of a hazardous site
- Operating in confined spaces as defined in training bulletins or other standard operating guidelines
- Other than structural operations, emergencies as necessary, etc.

Removal of CBRN SCBA under these conditions is also regulated locally, but generally, when responders operate in smoke, toxic CBRN atmospheres, they should not remove the CBRN SCBA facepiece except as directed or when conditions are determined as follows:

- When in a clean area
- The cylinder is depleted and in a clean area
- The SCBA is malfunctioning so as to terminate air supply and enough respirable air is available to allow egress
- The downed firefighter SCBA is empty and a rapid intervention team (RIT) responds in a life saving support mode with no risk to agent exposure

The emergency responder must be aware that the risk of removing the facepiece in a CBRN environment may result in exposing him/herself or the intended-to-be-rescued person, to a minimal, significant, or fatal exposure. CBRN agents are more lethal, toxic, potent, and faster acting than other toxic hazards normally encountered on the fire scene or crime scene.

The sharing of CBRN SCBA between emergency responders is not recommended, whether it is the same facepiece that is being shared, the entire SCBA or separate breathing zone components of the SCBA. Rapid intervention team (RIT) response may require the sharing of respirators to allow escape. If used, the practice of going on and off air, as the situation allows, in CBRN contamination, is very likely to cause minor, to major CBRN agent exposure, resulting in acute or chronic health conditions or death.

The use of "bite bars" or other devices designed to modify the air pressure boundary of a CBRN SCBA are not recommended. Emergency responders are cautioned against jeopardizing their health by non-compliance with NIOSH CBRN SCBA approval requirements, non-use of appropriate NIOSH CBRN approved respirators or by the possible use or mis-use of non-manufacturer specific modifications or adapters while using the CBRN SCBA.

4. B. 5. CRUL Concept Related to Use Conditions

CBRN SCBA have standard NFPA and NIOSH EOSTI. The use EOSTI is highly recommended to ensure that proper escape/egress time is pre-planned and executed. Any local changes to the SCBA manufacturer's set EOSTI are the responsibility of the manufacturer and, if required, the organization/department/agency that purchased the SCBA. Significant modifications to approved EOSTI engineering designs require NIOSH evaluation to maintain approval.

CBRN SCBA cylinders and components have an expected service life and service time, and when contaminated, an expected in-use life (CRUL = six hours). EOSIT relevant to both service life and use life should be observed.

An improvised CBRN agent contamination use life "indicator" program may use default timing patterns that rely on a stoppage of respirator use at the three to five-hour CRUL mark. This does not change the CRUL time value of six hours, but provides a safety factor to allow the responder to egress. On-the-job workplace detection methods will determine the start of the CBRN SCBA CRUL. Processing of contaminated SCBA at that time, may involve SCBA equipment quarantine until environmental sample results from the response scene are available one, two, or three days later. Most likely, if sample results do not confirm the type of contamination within one day, contaminated CBRN SCBA in the default timing pattern should be considered for discard due to the potential for chemical agent permeation.

Field-deployed SCBA upgraded to CBRN protection have unique use life challenges. A retrofitted SCBA to CBRN protection that is used for six hours in a CBRN chemical agent contamination response cannot have select retrofitted parts changed out and replaced and the retrofitted CBRN SCBA made serviceable again for use. Chemical agents do not distinguish between old or new respirator parts, just the susceptibility of the material to penetration or permeation effects.

4. B. 6. CAUTIONS AND LIMITATIONS STATEMENTS

NIOSH cautions and limitations (C&L) are lettered and cover a variety of industrial and CBRN respirator approvals. They are understood to be assigned by NIOSH in alphabetical order and certain letters may appear to be missing in certain NIOSH respirator specific publications. They are missing because they are not applicable to the class of respirator or type of protection being addressed. For example, CBRN SCBA C&L are lettered I, J, M, N, O, S and then Q, R, T and U. The missing cautions and limitations letters of "P," "V," etc., are not present because they are not assigned to that class of respirator.

4. B. 7. USE RELATED TO RIT OR RIC/UAC

RIT use universal air connection adapters and lines to mate up with SCBA of downed responders and provide the downed responder lifesaving respirable air. While the integration of a universal rapid air connection/universal air connection (URC/UAC) assembly or any extension air system accessory is recognized on a NIOSH-approved CBRN SCBA, NIOSH does not approve the RIC/UAC/URC/extension air system accessory female connectors or air sources in a CBRN environment. NIOSH approves only the

integral RIC/UAC male connector located on the approved CBRN SCBA hardware and not the actual connection of the RIC/UAC to a compatible interface in a CBRN environment.

4. B. 8. USE RELATED TO QUICK-FILL ® /QUICK CHARGE

The use of accessory air line hose assemblies on NIOSH CBRN SCBA to quickly fill depleting air cylinders under potential or CBRN contaminated environments is not approved by NIOSH. If quick charge/quick fill operations are done, the quick charge of a backpack mounted, compressed breathable gas cylinder should be done in a clean, protected, and 'CBRN contaminate free' area. And if performed in a contaminated area due to live saving priorities, the cylinder replenishment should be upwind of the contamination, completed as quickly as possible, and as directed by the incident commander or existing lead federal agency.

Rest cycles for responding personnel should be implemented. The most likely time for a responder to rest is when the air cylinder is being exchanged for a full cylinder.

4. B. 9. USE RELATED TO THE RED BY-PASS VALVE

A red colored by-pass valve is required to be present on all NIOSH CBRN SCBA. If a CBRN SCBA second stage regulator fails in the closed position, the red by-pass valve is used to provide forced compressed air into the breathing zone/nose cup while by-passing the second stage regulator. The actual turning of the by-pass valve to purge the air line has not been done under NIOSH CBRN SCBA certification test procedures. However, NIOSH has demonstrated that the purge valve does maintain a safe air pressure boundary while disengaged in CWA LAT because the by-pass valve did not fail or contribute to failing properties of the tested CBRN SCBA. Since the air pressure boundary at the purge valve does not allow GB, HD or corn oil penetration or permeation while the boundaries are pressurized, it is likely that activating the purge valve will not have an adverse effect on the wearer when CBRN agents are present. However, further research and testing is warranted in this area to determine the effects caused by turning the by-pass valve on in a CBRN contaminated environment.

Note: **Operating the by-pass valve, also commonly known as the purge valve, should only be used for escape purposes. Emergency responders wearing CBRN SCBA should exit the scene in accordance with local requirements, when any type of malfunction is detected on the CBRN SCBA. Using the red by-pass valve will expend air at a faster rate from the compressed air cylinder of the SCBA and provide an immediate flow of rapid breathable air into the breathing zone of the user. Emergency responders that have must be thoroughly trained in advance to use the by-pass valve as an escape method under CBRN conditions.**

4. B. 10. CONTAMINATION TRANSFER

In the situations where gear bags or other equipment are brought into a CBRN contaminated area, responders should exercise caution as it relates to contamination transfer from those items during the egress. The use of gear bags or extra vital equipment during a CBRN response may serve to spread contamination or unknowingly carry it to other exclusion zones of the site. Detection methods serve as vital measures to ensure that CBRN contamination has not spread, and is mitigated and contained within workable exclusion zones.

Once the equipment is brought into the hazard area, the only way out should be through a decontamination lane.

4. B. 11. CBRN SCBA FAILURE

A CBRN SCBA can fail from fair wear and tear or component malfunction without exposure to CBRN agents. If CBRN contaminates are suspected or known to be inside your facepiece, close your eyes, hold your breath, use the by- pass valve to purge/flush suspected contaminates out as fast as possible, reseal the facepiece and grossly decontaminate known agent locations on the equipment and yourself, and then, or simultaneously, immediately escape out of the contamination.

With proper responder training CBRN SCBA are not expected to fail. The respirator must be fully serviceable, worn correctly and used correctly.

CBRN SCBA failure indicators may be rapid or slow. Penetration or permeation of CWA, TIC or biological contaminates into the breathing zone will likely be the first indicator that agent has penetrated or is starting to penetrate. A second indicator may be grazing or seam cracking of select material surfaces, especially those under pneumatic pressure or manual tightening. If failure indicators are seen conduct an escape risk assessment based on the amount of air left, mission requirements and expected egress time to complete the mission.

If catastrophic failure of a CBRN SCBA occurs due to a failing cylinder, the emergency responder must perform a quick release of the SCBA or be prepared for serious injury or death due to the sudden kinetic energy expenditure of pressurized air from a cylinder neck valve breach, crack, or external causes. Depending on the level of protective suit ensemble or duty uniform worn, the SCBA harness assembly and cylinder will present significant hazards to the wearer while it is discharging. If hastily removed, the responder may likely sustain lesser injuries than if the responder kept it on and tried to ride the discharge out. The need for further research is warranted relative to catastrophic cylinder breaches under fire, law, hazmat and emergency medical response conditions.

If possible, the by-pass valve "purge-on" action is an option for escape purposes when the breach is noticed and as soon as any sign of SCBA failure is detected.

The responder two in-two out OSHA rule is even more critical in CBRN responses. Much like routine fire responses, the use of buddy teams/two-man rule (OSHA 2 in, 2 out) should assist in detecting pre-failure indicators. For lengthy decontamination processes, industrial supplied air line respirators (SAR) with compressed air cylinder escape bottles are an option for use, provided the air lines are kept clean of contamination. As of 2005, NIOSH has not approved SAR with CBRN protection.

4. B. 12. CBRN SCBA ACCESSORY FAILURE

CBRN SCBA accessory failures, due to malfunction or CBRN caustic effects, may render the respirator unusable. If the failing accessory has no effect on form, fit, or function the accessory cab be discarded. If a specific accessory is splashed with liquid CBRN agent, such as the integral PASS device, the remaining SCBA hardware may not be contaminated. Monitoring of the SCBA with litmus paper sampling (known as "papering") or use of a handheld calibrated point detector may assist in determining the range of

contamination splatter on a CBRN SCBA. Knowing exactly where the contamination is located on the equipment assists in more rapid surface decontamination. Gross decontamination should nevertheless, still be done with the understanding that toxic run off should be prevented from contaminating the rest of the SCBA and surrounding area. Contamination avoidance through the use of fine spray nozzles or localized washing of suspected components of the CBRN SCBA may reduce the amount of contamination from spreading, penetrating or permeating equipment surfaces.

4. B. 13. WITHDRAW

Only clean, non-contaminated CBRN SCBA should be withdrawn from the incident site in accordance with the relevant local departmental protocol. CBRN SCBA contaminated with chemical warfare agents should not be withdrawn for any reason, especially future use, from an incident site. Contaminated CBRN SCBA should be handled appropriately through a defined equipment route for proper decontamination, accountability and eventual disposal.

4. B. 14. ESCAPE

The CBRN SCBA does not provide an integral escape bottle or other means of escape air, except through use of the by-pass/purge valve or RIT. Use of RIT to provide replenishment air is subject to incident commander authority and most likely will only be used to save a life, but not to extend work times in a CBRN environment.

4. C. AFTER OPERATIONS

4. C. 1. Unmasking Procedures

Unmasking procedures or removal of the facepiece while on air should only be performed after the ambient air has been characterized to be below the determined safe exposure limits for a particular CBRN agent or agents. NIOSH CBRN SCBA should not be removed for any reason while the user is still in a CBRN contaminated environment. Before unmasking procedures are conducted, ensure that local decontamination of equipment has been performed. An appropriate decontamination procedure should be selected based on the type of contamination involved, known effectiveness of the procedure, availability of decontamination materials, and ease of decontamination process implementation. The use of qualitative detection technologies, coupled with voluntary unmasking procedures (unmasking procedures with or without the M256A1 kit) is not recommended in an actual or suspected hot or warm zone of a CBRN incident.

4. C. 2. Doffing

Doffing/removing the CBRN SCBA is a deliberate process outlined in user's instructions. In the case where CBRN contamination is known to exist, removing the CBRN SCBA should only be done under strict contamination control measures and decontamination procedures. If the CBRN SCBA is clean, doffing should be done in a safe area.

4. C. 3. Handling of CBRN SCBA

Handling is defined as to touch, lift or hold with the hands. The respirator may be lifted with the hands or remotely by robotic tools. NIOSH CBRN caution & limitation letter 'T' states that *direct contact with CBRN agents requires proper handling of the SCBA after each use and between multiple entries during the same use.* Proper handling of CBRN contamination may prevent it from spreading and also prevent cross contamination of known clean items. If re-entry is performed while using the same CBRN SCBA, use recommendations should be strictly observed. Handling of contaminated CBRN SCBA should contain and mitigate all forms of CBRN contamination in accordance with the correct procedure relevant to the type of agent exposure. Universal handling procedure used by hazardous material operators are recommended in accordance with OSHA HAZWOPER requirements. Actual handling of contaminated CBRN SCBA requires proper dermal and respiratory protection appropriate to the type of agent exposure. NIOSH-approved CBRN SCBA and NIOSH-approved CBRN APR are recommended as respiratory protection during handling of contaminated CBRN SCBA equipment scheduled for disposal.

4. C. 4. Individual SCBA Decontamination

If known CBRN contamination is present on the CBRN SCBA, the most effective action is gross decontamination with water to remove any visible or detectable type of CBRN agent. CWA will not be neutralized by water, but rather diluted to a safe level and physically washed off equipment surfaces. It is expected that massive amounts of CBRN particulates will be washed off, yet trace particulates will likely remain in intricate crevices of the CBRN SCBA. Gross decontamination with water is expected to limit CWA agent penetration and permeation. The processing of CBRN SCBA for use or disposal is dependent on sampling and monitoring results. If SCBA are confirmed to be contaminated by public health laboratory results, responders can use back planning/default in-use life timing rules where the CBRN SCBA that was suspected of being contaminated is now known to be contaminated, or clean, and is then used in known contamination for an additional 3- to 5-hours if it was known to be clean or, if it is known to be dirty/contaminated, its use does not exceed the total six-hour limit.

4. C. 5. Individual Facepiece Decontamination

In Level B OSHA/EPA protective ensemble protection or other standard ensembles such as NFPA 1991 or 1994 classes of suits, only the facepiece, second stage regulator or air hatch, and hose assembly are or may be exposed. Washing down those particular parts of the respirator with copious amounts of water may limit the amount of CBRN contamination spread to the remaining areas of the CBRN SCBA. However, the controlled replacement of only the contaminated parts of the CBRN SCBA is not recommended. Any attempt to continue to use the un-contaminated components of the SCBA will not prevent cross contamination of the interior air-pressure boundaries.

4. C. 6. CBRN SCBA Cylinder and Hardware Decontamination

For biological response, EPA guidance calls for the use of adjusted pH bleach on hard surfaces. See the link for additional information on adjusted pH:
http://www.epa.gov/pesticides/factsheets/chemicals/bleachfactsheet.htm

A CBRN SCBA used in a biological response may be decontaminated with soap and water and a neutral 0.5% hypochlorite solution. This solution, close to, but not above, a pH of 7, and 5,000 to 6,000 parts per million in strength, can be prepared by mixing one part bleach (5.25%-6.00%) to one part white vinegar, to eight parts clean water. The bleach and vinegar liquids are not poured together into a container at any point in time; rather, first add bleach, then some water is added to the bleach, then all the vinegar, and then the rest of the water. Ensure that pH test strips are available. The pH of the solution must be tested routinely with a paper pH test strip. Treated surfaces must remain in contact with the bleach and vinegar-water solution for 60 minutes and repeated applications or emersion will be necessary to keep the surfaces wet. Additional CBRN agent decontamination methods are available at the CDC search engine link http://www.cdc.gov/az.do#S.

4. C. 7. Detection Methods In Support of Decontamination Operations

To determine the effectiveness of decontamination operations, relevant detection instruments should be used to confirm that CBRN agent decontamination has been effective. The current source point or direct read quantitative monitors available for CBRN detection are limited in type and capability. Most of the available technology has limited sensitivity and selectivity. Detection methods using laboratory results to confirm the effectiveness of decontamination is currently the best recourse.

Qualitative monitoring devices such as U.S. Army M8 paper, M9 tape, M256 kit, M256A1 kits, CAM, ICAM, ACADA, or other detection equipment may not provide the degree of quantification necessary to fully determine CWA presence or absence. Users should rely on repeatable results from certified public health or federal laboratories to substantiate key decision-making processes. In the interim, the repeated use of reliable qualitative monitoring devices to help in establishing site control measures and exclusion zones may prove beneficial until quantified results are available. Next generation biological agent detection measures are improving daily but are not field deployed yet at the individual user level. Radiological agent detectors are available to quantify dosage, presence and removal of radiological particulates. See the NIOSH emergency response cards for specific guidance on occupational exposure limits and available guidance on sampling and analytical methods appropriate per type of CBRN agent.

4. C. 8. Recommendations for Disposal

Once decontaminated to the safest possible level, CBRN SCBA require special handling for disposal. Users of CBRN SCBA will likely not have the decontamination resources to bring CWA contaminated SCBA to regulatory HAZWOPER levels of disposal. Users should ensure that all types of CBRN SCBA, regardless of the type of contamination, are double bagged in the appropriate shielding material, labeled with the type of agent or agents, and the amount and type of gross decontamination solution used. The length of time the CBRN SCBA has been exposed to contamination, the concentration and the amount of contamination involved are all factors that beneficial information relative to disposal. Adherence to local, state, and federal disposal procedures involving incineration for specific CBRN agents is required. All measures necessary should be used to contain and properly dispose of contamination run-off. Disregard for run-off containment can lead to further contamination spread and possibly human life exposure or re-exposure, as well as environmental area destruction.

4. C. 9. Cleaning and Sanitization of CBRN SCBA

A CBRN SCBA contaminated with CWA cannot be cleaned and sanitized for any type of re-use. CBRN SCBA contaminated with biological particulates, biological toxin, or radiological particulates require detailed decontamination, and inspection, if intended for re-use. Most likely re-use will not be cost effective depending on the conditions of biological or radiological contamination.

Recommended cleaning and sanitization procedures for CBRN SCBA not contaminated with CBRN agents should follow the manufacturer guidelines for traditional SCBA. Additional information on cleaning and sanitizing respirators developed during the World Trade Center response is located at http://www.cdc.gov/niosh/respcln.html

4. C. 10. INTEGRATING SCBA WITH PROTECTIVE SUITS

NIOSH-approved CBRN SCBA and NIOSH-approved industrial SCBA are integrated by all types of emergency responders into EPA/OSHA Level A, Level B, Level C protective equipment ensembles, NFPA ensembles, military mission oriented protective postures (MOPP), military self-contained toxic environment protective outfits (STEPO) or improved toxicological agent protective ensembles (ITAP). They are also used with explosive ordnance disposal (EOD) suits.

As of 2007, NIOSH CBRN standards do not exist for protective ensembles/suits-gloves-boots; therefore, the NIOSH/NPPTL does not certify protective ensembles to a CBRN protection. Next generation chemical/ biological protective ensembles are being developed by select private sector companies under contract to the Department of Defense and the NFPA. NIOSH certifies CBRN respirators as systems, not individual components and integrating a protective suit into a respirator system/configuration is outside the scope of current NIOSH congressional mandates. Consequently, NIOSH does not certify protective ensembles/suits as major components of a NIOSH CBRN respirator approval.

However, there are several aspects of respirator and suit use that is relevant to the integration of a CBRN SCBA with protective suits. They are aspects involving chemical suit pass-thru-devices, HAZWOPER Level A, B and C protections, CRUL values while wearing a protective ensemble, CBRN SCBA facepiece interface methods, and EOD suits.

4. C. 10 –a. INDUSTRIAL PROTECTIVE ENSEMBLE/CHEMICAL SUIT PASS - THRU DEVICES

CBRN SCBA, with approved auxiliary hose line assemblies, may interface successfully with stand-alone, integrated, specific chemical suit pass thru devices. These pass-thru devices allow airline connections to literally "pass through" designed Level A suit openings. They normally consist of airline pigtail designs using Hansen, Schrader, or Foster connections. A special adapter from select respirator manufacturers is available for Level A suits. Airline pigtail or auxiliary hose line assembly, present on NIOSH-approved CBRN SCBA, may allow the SCBA to have air resupply but only in clean atmospheres.

The use of a chemical suit pass-thru device in CBRN environments is situation dependent and at the discretion of the incident commander. Currently, NIOSH does not issue CBRN protection approval to chemical suit pass-thru devices. However, the integrated SCBA air line and fittings that connect to the pass-thru devices are

NIOSH-approved in the first tier of approval. Interchangeability of the suit pass-thru device for purposes of establishing interoperability between suit manufacturers is recognized by NIOSH at this time

Note: The pigtail interface is not live agent tested to allow successful mating of an external airline to the pigtail under CWA conditions.

4. C. 10 – b. OSHA HAZWOPER and OSHA/EPA LEVELS A, B, C, AND D

Industrial hazardous waste operations and emergency response (HAZWOPER) operations combine different classes of respirators with different types of protective clothing. The complete outfit, consisting of a respirator, suit, gloves, boots and other necessary accessories, is called an *ensemble*. Protective suit ensembles used in HAZWOPER are commonly described as levels of increasing respiratory protection starting at the lowest level of protection, Level D, and progressing to C and B, and culminating at the highest level of protection, Level A [OSHA 1997]. As required by OSHA, personal protective equipment must be selected that will protect employees from the specific hazards that they are likely to encounter during their work on-site [OSHA, 1997].

The amount of protection afforded by selected PPE is material/hazard specific and dependent on accurate characterization of the workplace environment before entry. OSHA/EPA levels of protection D, C, B, and A are designed to provide increasing levels of dermal and respiratory protection from vapor, liquid, aerosol, and particulate contamination. Levels A and B provide higher levels of respirator and dermal protection than levels C and D. SCBA are required in Levels A or B ensembles. CBRN SCBA meets the OSHA respiratory requirements for HAZWOPER Levels A and B.

CBRN SCBA, used in conjunction with a new Level A ensemble, are expected to stay contamination free, depending on the quality assurance testing of the suit and local compliance to OSHA or EPA standards, and if applicable, the NFPA code. However, if the Level A ensemble is compromised thru fair-wear-and-tear, snags, collateral damage from a secondary device, or poor quality construction, the user should expect the NIOSH-approved CBRN SCBA to continue to provide its accepted standard of performance, even though the interior of the suit ensemble may be harboring dangerous respiratory or dermal agents.

Level A is considered the highest level of protection and is thus the most stressful on the wearer. In Level B or Level C ensemble configurations CBRN SCBA are worn exposed to the ambient atmosphere. In some responder communities, head harness straps are even worn over of protective ensemble hoods while in Level B or C.

CBRN SCBA worn with the head harness of the SCBA exposed to the ambient atmosphere could jeopardize the intended sealing properties of the facepiece and contribute to penetration of the wearer's breathing zone.

Please ensure that the CBRN SCBA head harness is donned on the user's face, head first, and then the protective suit hood is donned over the head harness. Necessary measures to bridge the gap between the respirator face blank and the protective suit hood and neck material should be taken as deemed appropriate by local ISO/HSO.

Integration of CBRN SCBA with firefighter turn out gear, law enforcement tactical gear, Level A, B, C and D hazardous waste protective suit ensembles, NFPA 1994 Class 1, 2 or 3 ensembles, and NFPA 1991 ensembles or any other protective barrier/suit used by the incident commander is possible. A direct transfer of the common industrial hazardous materials and waste response capabilities to the realm of CBRN incident response makes tactical sense, provided certain improvements and modified tactics, techniques, and procedures are identified and made available in current field deployed PPE and next generation protective clothing and respirators. Incident commanders may weigh the constraints that Level A or Level B ensembles place on the responder and decide to use CBRN SCBA with a Level C ensemble for a specific tactical response. If this occurs, NIOSH-approved CBRN SCBA is approved as a stand alone respiratory protection device.

As stated, how respirators are integrated with other types or levels of protective ensemble protection is not a NIOSH requirement for the respirator's certification. NIOSH-approved CBRN SCBA will provide the required level of respiratory protection, provided they are used correctly. NIOSH-approved CBRN SCBA are not currently approved in tandem with any protective suit ensemble or suit sub-component. As discussed, respirator manufacturers outfit SCBA with compatible accessories for SCBA use in protective suit ensembles, such as suit pass-thru devices, auxiliary hose assemblies and rapid intervention team or crew/universal accessory connection accessories that support SCBA compatibility with protective suit ensembles and portable air sources. Use of these compatible accessories for CBRN incident response is at the discretion of the incident commander or lead federal agency officer in charge.

4. C. 10 -c. CRUL Related to Use with Protective Ensembles.

CBRN respirator in-use life (CRUL) of a CBRN SCBA does not start unless the protective suit ensemble is breached and allows minor to significant agent contamination of the SCBA. Having a CBRN SCBA on under a Level A suit provides a barrier of protection to the CBRN SCBA, and allows the in-use life clock to not start on the CBRN SCBA until the respirator becomes contaminated. Level A use does not change the CBRN respirator in-use life time value of six hours (CRUL = 6) but it does control the rate of contamination on the SCBA. A non-federal compliant and tested suit can provide a level of protection to the CBRN SCBA from splash and vapor hazards, provided it has passed current available third party CBRN consensus standards such as NFPA 1994 or 1991. However, if that ensemble is breached by normal wear-and-tear, snagging, tangle, cutting or by penetrating hazards, the interior of that ensemble, Level A or next generation ensembles of a Level A type, may allow hazardous CBRN agents to accumulate and contaminate or expose the dermal areas of an emergency responder. Suit protection factors exist but they vary according to suit design and manufacturer.

4. C. 10 - d. CBRN SCBA FACEPIECE SEAL COMPROMISING

Doffing of the protective suit ensemble should not adversely impact the sealing properties of the NIOSH-approved CBRN SCBA facepiece, provided doffing actions are not overly severe. An adequate respirator human-face-to-faceblank-seal should be maintained by the user or by use of the two-man rule/buddy team, while doffing protective suit ensembles.

4. C. 10 - e. EXPLOSIVE ORDNANCE DISPOSAL SUITS

Explosive ordnance disposal (EOD) bomb squad suits are designed to provide chemical and biological protection during low threat explosive ordnance detonation or improvised explosive device disposal operations (IED) involving CBRN agents. Select NIOSH CBRN SCBA are compatible for use with EOD suits. NIOSH-approved CBRN SCBA are worn on the outside of the bomb suit. For additional information about EOD suits available to emergency responders see http://www.med-eng.com/medeng_products_en/medeng_products_display_product.jsp?pID=5.

The following links contain relevant information pertaining to protective suit ensembles and respirator integration for CBRN response:
Biological: http://www.bt.cdc.gov/documentsapp/Anthrax/Protective/10242001Protect.asp
Chemical: http://www.bt.cdc.gov/agent/agentlistchem.asp
Radiological: http://www.bt.cdc.gov/radiation/pdf/MassCasualtiesGuidelines.pdf

Projected user needs in reference to NIOSH CBRN SCBA standards and user guidelines are many. Users can be categorized by the type of public safety mission they perform. Projecting the type of next generation personal protective equipment these users needs is contingent upon knowing and understanding their workplace or response needs.

A CBRN respirator guidelines cycle that uses standard development and hazard assessment as its starting points can depict how NIOSH CBRN respirator user guidelines can assist workers. NPPTL publishes user guidelines to support, advise, assist and train. Users at the local city, county, state and federal levels use the guides to assist in their response. Appendix C is a schematic that depicts CBRN respirator guidelines cycle.

Firefighters and law enforcement responders use SCBA that are NIOSH-approved, as well NFPA 1981 compliant SCBA. These standards address certain respirator manufacturer requirements that are unique to firefighting and operations in hazardous atmospheres. In October of 2001, these standards did not address potential CBRN agents which could potentially penetrate or permeate the SCBA. Analysis of potential hazards and materials of construction of the SCBA led to the conclusions that the characteristics of the "facepiece to user" interface required verification for each SCBA marketed to the public workforce. Because gas and vapors are more penetrable than radiological and biological particles, the focus of SCBA CBRN testing was on chemical gas, vapor and aerosol penetration or permeation.

Currently, CBRN self-contained breathing apparatus approved by NIOSH provide minimum respiratory protection against these agents; however, responders at the site may have only part of the information necessary to select the type of appropriate complimentary personal protective equipment (PPE) for the response. In situations where it is an initial response to a suspected CBRN terrorism incident, an actual CBRN incident, or a follow on response to a known CBRN incident, protection of the respiratory system is paramount and NIOSH CBRN certified, open-circuit, pressure-demand, self-contained breathing apparatus are highly recommended for use.

Selection of PPE for CBRN incident response requires a knowledge level commensurate with current experience in wear time, use time, maintenance time, and recovery time of PPE. Recent NIOSH Respirator

Selection Logic (RSL), dated October, 2004, http://www.cdc.gov/niosh/docs/2005-100/ is not intended to be used in the selection of respirators for protection against infectious agents or for CBRN agents of terrorism. While the industrial respirators identified in the RSL can provide a variable level of protection against some of the irritating military or law enforcement riot control agents, such as CS, CN and pepper spray, they are not live agent tested against CWA by NIOSH and can, in fact, exhibit catastrophic failure when exposed to HD or GB while in a confined space.

Additionally, the process safety information necessary to use the industrial respirator selection logic (RSL) is generally not available for infectious disease or bioterrorism agents (e.g., defined exposure limits and airborne and dermal concentrations). Likewise, CBRN terrorism attacks may involve toxic industrial compounds or military grade/terrorism grade chemical warfare agents that can quickly degrade industrial respirator materials and penetrate industrial respirator silicon or other material air-pressure boundaries. These toxic compounds and agents can build up in industrial respirator air-pressure boundary dead-spaces not flushed by exhalation air flow or have an extremely low toxic level that is difficult to quantify and measure on the incident site, resulting in a lack of proper respirator performance.

4. C. 11. INTENTIONS FOR USE

NIOSH CBRN SCBA respirators are intended for use by trained emergency responders for specific entry into or escape from unknown, known, suspected, or partially characterized CBRN hazardous environments. A hazard is defined by OSHA as the inherent capacity of a substance to cause an adverse effect [OSHA, 2003]. The DHS NRP defines a hazard as something that is potentially dangerous or harmful, often the root cause of an unwanted outcome. Defining a hazard helps in deciding how to respond to it. Emergency responders could respond to single, multiple or combination CBRN hazards. Safe incident response requires the use of appropriate personal protective equipment. CBRN SCBA respirators are part of the range of PPE selection. At a CBRN emergency response hazardous event, respirators providing the highest level of protection should initially be used, and routinely used, as the mission dictates, until hazard types and concentrations are quantified and exposures are determined to be compatible with less protective CBRN respirators. Currently, the respirator configuration that offers the highest level of respiratory protection and inherent facial dermal protection is the NIOSH CBRN SCBA. Emergency responders and first receivers should use CBRN SCBA in conjunction with personal protective ensembles that provide appropriate levels of protection against dermal hazards.

A joint OSHA and NIOSH interim guidance document was published on the internet on August 30, 2004. It provides CBRN PPE selection matrix guidance based on potential toxicological levels of exposure. It defines red (hot), yellow (warm) and green (cold) zones and provides PPE recommendations for each zone, as they relate to CBRN contamination. The link to the joint OSHA/NIOSH CBRN PPE selection matrix is: http://www.osha.gov/SLTC/emergencypreparedness/cbrnmatrix/index.html.

Law enforcement responders (LER) are using PPE, especially SCBA and APR. Clandestine lab entries are typical examples. CBRN responses/training is another. Standard Mil Spec and now NIOSH industrial and CBRN approved "Gas Masks" have been and will continue to be integral to law enforcement personal protection. See the link.www.NTOA.org for examples. One example is a course entitled *Tactical Use of SCBA in Hazardous Environments.*

PPE selection logic for LER are mission specific and do vary from sister responder services. NFPA compliant SCBA are not designed for LER mission response-they are designed for fire response. While they will provide protection and fire resistance to explosions, their ergonomic and tactical design is not totally optimal for a law responder. Ergonomic and technical improvements are needed for LER to gain maximum benefit from next generation PPE technology. Ballistic protection of cylinders, noise and light discipline of gauges, visors, exhalation valves, and redundant air pressure alarms, and Level D/C/B ensemble interface with ballistic vests are all next generation projected user needs that require standards publication. Explosive ordnance disposal technicians have similar needs. Military operations have routinely integrated land, sea, and air forces to accomplish a mission. Applying that joint land, sea and air type mentality to civilian response organizations may benefit emergency responders.

Tactical operators/responders must be of highest integrity and honor. Use of deadly force to accomplish local missions carries significant responsibility: responsibility that prevents/contains out of control response when chaos ensues. DoD/USCG rules of engagement (ROE) are tailored to support local law enforcement and fire responders in the accomplishment of restoring law and order, infrastructure and recovery from natural disaster aftermath--that will also be the case in the event of a nationally significant CBRN attack(s). Natural disasters show that layers of emergency responders will be hampered, constrained or decimated and the lessons learned from ongoing emergency management operations can be multi-purpose in current and future applications at all levels of response.

4. C. 12. FUTURE GENERATION CONCEPTS

NIOSH offers CBRN protection approval for several other types of respirators. They are available as manufacturers gain NIOSH CBRN protection approval. They include the tight fitting, full-facepiece air-purifying respirators (APR) for emergency responders, a self-contained escape respirator (SCER) and air-purifying escape respirators (APER) for use by general working populations as well as CBRN powered air-purifying respirators (PAPR), CBRN closed circuit SCBA (CC-SCBA) and CBRN combination SCBA/PAPR/APR devices.

NIOSH is continuing its efforts to publish special hazard CBRN use guides and intends to generate peer reviewed documents pertaining to various classes of CBRN approved respirators. These guides will utilize NIOSH public CBRN statement of standards as technical performance references.

APPENDIX A: SCBA Benchmark Observations

Executive Summary: SCBA were mounted on a SMARTMAN headform and contaminated with known concentrations of toxic nerve agent (GB/Sarin) and toxic blister agent (HD/Mustard) over time, in a controlled laboratory environment. Two identical "domestic preparedness" market SCBA, per public manufacturer, were provided to SBCCOM via the NIOSH and ISEA request for the survey. The tests were conducted at Building E-5100, Edgewood Chemical, Biological Center (ECBC), Edgewood Area, Aberdeen Proving Ground, MD, over the timeframe of October 17-31, 2001. Nine models, totaling to 18 SCBA, were successfully benchmark tested. At the time of the survey a pass/fail criterion was not required or established since the purpose of the test trials was to observe the submitted SCBA for catastrophic failure or survivability against known CASARM program neat chemical warfare agent concentrations. 9 SCBA were contaminated with GB. The same 9 models but different respirators were contaminated separately with HD and observed. All 18 SCBA and supporting RDECOM experiment procedures were successfully benchmarked. Catastrophic failures and effects were witnessed. Breathing zone concentrations were generated and manufacturers were provided individual binders that documented the performance of their respirators. NIOSH successfully concluded that traditional NIOSH and NFPA certified SCBA were not sufficiently designed to protect an emergency responder in a chemical warfare environment. A NIOSH respirator performance standard for SCBA with CBRN protections was needed.

Benchmark Survey Time Period: October 17 – 31, 2001, Edgewood Chemical Biological Center (ECBC)

Date of Observation Report: November 27, 2001

1. **Requirement:** Conduct joint scientific laboratory experiments to determine the catastrophic effects of vapor, aerosol, and liquid chemical warfare agent (CWA) (GB and HD) on NIOSH-certified self-contained breathing apparatus (SCBA) while mounted on a U.S. Army head form breathing at a determined NIOSH airflow rate. Generate scientific statistical data of the concentrations detected in the SCBA breathing zone by sampling the oral –nasal area using a calibrated military specified analytical monitoring instrument platform in a controlled chemical surety program laboratory. Document visual effects created by chemical warfare agent on SCBA material surfaces and confirm the need for rapid development of a novel NIOSH-certified CBRN SCBA performance standard for emergency responders to use in CBRN terrorism incidents. Create all air flow adapters and sampling interfaces to successfully test a high pressure SCBA using available pressurized air sources and mounting platforms. Evaluate CWA agent flow rates and design standardized HD droplet diagrams that indicate where HD liquid droplets are manually applied to the SCBA facepiece and remaining hardware in an effort to efficiently and rigorously evaluate the existing protective qualities of the SCBA material, design, and respirator integrity over a given test period. Evaluate each SCBA in a non-agent chamber before contaminating it in an agent chamber by utilizing available particulate science technology to sample for air leaks while mounted to a static headform in an effort to prevent gross leaks in the respirator from saturating the agent chamber detectors.

2. **Goal:** The goal of the benchmark survey is to safely contaminate, sample, record, and decontaminate select SCBA respirators provided by the participating stakeholders of the public sector International Safety Equipment Association (ISEA) and non-ISEA stakeholders. Generate proprietary electronic raw data for each SCBA observed and provide that separately to each participating manufacturer at the conclusion of the benchmark testing. Rely on available U.S. Army technology to adequately sample and monitor the breathing zone of the SCBA and generate repeatable raw data by using a single MINICAMS Series 3000 instrument per agent hood and existing U.S. Army live agent test protocol. Note that the house air for the U.S. Army laboratory is the only available pressurized air source. Create a novel 20 psig air line adapter that allows the SCBA neck cylinder valve to be interfaced with the house air line and not rely on the breathing air cylinder limited duration air pressure for the conduct of the determined test time. . Collate and draw conclusions from generated raw data and visual observations of SCBA integrity during each of the 18 trials. The raw data is summarized in enclosures B-1, GB LAT Observations and B-2, HD LAT Observations.

   a. **Benchmark Protocols:**

Figure 1: GB LAT, October 18, 2001 Figure 2: HD LAT, October 22, 2001 Figure 3: Prep for HD drops

GB Protocol

1.) Live agent test for GB consisted of 2000 mg/m3 of GB vapor/aerosol in a confined area chamber box as shown in Figure 1, housing the SMARTMAN headform fitted with the entire allowable 120 psi pressurized SCBA with one-hour cylinder.
2.) GB vapor contamination was for first 30 continuous minutes.
3.) At the 30 minute mark GB vapor was terminated and SCBA was observed for 5.5 hours. Total time of initial survey test was 6 hours per GB trial.
4.) If the SCBA did not catastrophically fail during the first 6 hours, a second dosage of 2000 mg/m3 of GB was injected into the box for an additional 6 – 25 hours or until the MINICAMS pre-saturation point was reached, whichever came first.
5.) Upon termination of test, SCBA was hastily decontaminated, plastic bagged and removed for complete decontamination prior to disposal as hazardous waste.
6.) NIOSH and US Army SBCCOM representatives observed the SCBA performance during the first six to twelve hours. Remaining test hours were unobserved and in a secure lab overnight. SCBA performance tests and decontamination was documented by RDECOM ISO 9000 protocols.

HD Protocol

1.) An identical separate SMARTMAN headform and chamber were used for HD contamination of an identical second SCBA. Figures 2 and 3 show how 43 droplets of HD liquid, 10ul per droplet, were manually applied to the SCBA facepiece and specific SCBA hardware to test the permeation and penetration effects of HD on a 120 psig house air sourced SCBA with one hour cylinder and select accessories. 25 drops to the facepiece and 18 to the remaining hardware.

2.) After droplet application was complete, SCBA was encased and 300 mg/m3 of HD vapor was introduced for 30 minutes.
3.) After a combined vapor and liquid HD exposure for 30 minutes, HD vapor was terminated and SCBA was observed for remaining 5.5 hours
4.) If catastrophic failure occurred within first six hours, the HD test was terminated. If SCBA appeared to be functioning effectively after 6 hours an additional 6 hours was added to the observation time, but a second bump of HD agent was not introduced. Some systems were observed for as long as 17 to 22 hours, depending on agent introduction start date and weekend timeframe.
5.) At the termination of a test, the SCBA was hastily decontaminated, plastic bagged, transferred to complete decontamination and inspected.

B. **Submitted SCBA and Accessories.** The below digital pictures are the types of SCBA benchmarked. All pictures are of the original SCBA as taken out of shipping cartons and assembled by manufacturer representatives, NIOSH representatives or SBCCOM personnel prior to contamination. In those cases where the SCBA manufacturer representatives were not on site at Building E5100, they were contacted by phone and participated electronically in the system configuration. All manufacturer representatives agreed in person or by phone as to the physical configuration of the SCBA prior to testing, its pressurized air source during testing and pre-test Posi-check results.

Figure 5: NFPA SCBA

Figure 6: Non-NFPA SCBA in vest.

Figure 7: HD drop locations

Figure 8: CWA kit on SCBA-Mil Spec

Figure 9: NFPA SCBA

Figure 10: NFPA SCBA with Shroud

Figure 11: Air Hatch NFPA SCBA

Figure12: EN SCBA

Figure 13: NFPA SCBA

Note: The 8 photographs represent 18 SCBA that were benchmarked. Figures 7 and 6 are the same SCBA.

C. **Observations:**

1. **GB:** General observations of GB tested SCBA consisted of monitoring the MINICAMS data screen, the magnehelic pressure gauge, the M8 cwa indicator paper located inside the chamber and general breathing of the SCBA. Catastrophic failures were noted by agent readings in the nose or eye detection ports of the SMARTMAN. The extent of agent penetration determined how long the SCBA was tested before the point of saturation of the MINICAMS caused the test to be terminated. Several data graphs show agent penetration spikes within the first two hours and a natural decay over the next 6 to 12 hours. Since GB is invisible, the penetrating and permeation effects of GB were indicated by detection instruments and post decontamination observations only.

2. **HD:** General observations of HD were the same as GB but more dramatic. Figures 14 and 15 are pictures of the same SCBA with its harness assembly and one-hour cylinder prior to HD application. Color-coded stickers were used to

identify where HD droplets were to be applied and help to locate the agent liquid effects on applied surfaces. The below system also shows a hydration reservoir attached to the SCBA drinking tube assembly. Reservoir was not filled with water.

Figure 14: Color coded stickers showing HD planned droplet locations for SCBA LAT Figure 15: Areas below butyl shroud that were targeted are color coded.

3. **Catastrophic Penetration:** HD vapor and liquid effects were very aggressive on select components of the different types of SCBA. On some SCBA, HD did not aggressively attack the material surfaces while on others HD vapor and liquid penetrated and caused air-pressure boundaries to separate and crack or graze. Various unhardened plastics, silicones, and plastic materials allowed HD to penetrate, permeate, crack, and deteriorate material. Figure 16 shows the HD effects on a second stage reducer contaminated with HD aerosol-vapors only. The second stage reducer literally exploded with flying plastic pieces after being exposed to mustard agent. The orange silicone diaphragm is directly exposed to agent as a result of external housing/shut off button deterioration. See HD matrix to Appendix H, for cumulative Ct and max peak values.

Figure 16: Aftermath of HD on Second Stage Reducer. Brittle cracked edges evident. October 18, 2001.

4. **Hardened Materials:** HD did not appear to attack certain materials made of chemical agent hardened surfaces. However, if left standing on a surface it did graze select plastic surfaces and run off other hardened surfaces. Figure 17 shows the white HD grazing effects on an air pressure gauge.

Figure 17: HD grazing effects on air pressure gauge, October 18, 2001.

5. **HD Droplet Dynamics:** Figures 19 and 20 show liquid HD on hard coated polycarbonate/plastic surfaces and butyl rubber polymers. Agent adhered in droplets, ran, and eventually evaporated over time, leaving no visual effects on hard coated substrates. Permeation did occur in areas were HD collected/pooled. Extensive decontamination efforts were required to lower the contamination off-gassing and eventual disposal.

Figure 19: View of facepiece through protective chamber

Figure 20: HD droplet drain bead pathway on shroud

6. **Decontamination:** Figures 21 and 22 show the results of RDECOM laboratory methods for chemical warfare agent decontamination. Boiling and

caustic liquid emersion are two standard techniques to lower chemical warfare agent concentrations that have penetrated respirator material surfaces. Figure 21 shows the caustic effects on stainless steel from required decontamination solutions. Figure 22 shows components disassembled to ensure decontamination solution makes contact with as many material surfaces as possible. Re-use of the respirator is not recommended after contamination and then decontamination. Decontamination of SCBA cylinders is time and logistics intensive and requires cutting the cylinders to measure how effective decontamination has been.

Figure 21: Visible caustic effects on metal surfaces after decon.

Figure 22: Disassembly of regulators to allow surface decon

7. **Data Compilation:** LAT SCBA survey was successful in identifying SCBA performance traits against a known toxic agent concentration. Generated graphs depict agent penetration and permeation over time for select SCBA tested. Graphs allow initial conclusions to be developed without use of a specific breakthrough value. The survey did not utilize a breakthrough value, therefore no pass/fail criteria was generated. However, if pass/fail was determined it would use standard test procedure values under consideration. Graphs rely on RDECOM instrument raw data compilation and translation. Generic SCBA graphs are labeled as 1A – 9A for GB results and 1B – 9B for HD results. Summary GB and HD matrices identify observable trends that can lead to further product research and development. Laboratory testing equipment parameters and instrument performance were evaluated for improvement and resulted in refined criteria for utilization in NIOSH CBRN SCBA and follow on CBRN respirator standards development.

8. **Graphs:** Graphs depict the detected concentration of agent in the identified area of the SCBA breathing zone versus time. Six (6) areas of graphical data were compiled. Items "c" and "f" are available to specific manufacturers.

a. Master generic GB
b. Generic specific supporting master GB
c. Manufacturer specific GB
d. Master generic HD
e. Generic specific supporting master HD
f. Manufacturer specific HD
g. GB matrix of observations
h. HD matrix of observations.

NOTE 1: NIOSH team members responsible for NIOSH CBRN SCBA standard development program management and production where Les Boord, John Dower, Rich Metzler, Jon Szalajda, Terry Cloonan, Frank Palya, Mike Monahan, and Terry Thornton in a joint venture with the U.S Army Protective Equipment Team, Bldg E5100, ECBC, as of October, 2001.

NOTE 2: The information is a summary of NIOSH findings from first hand observation of Sarin (GB) and Sulfur Mustard (HD) live agent testing of industrial NIOSH-approved SCBA in a U.S. Army laboratory. The information gathered is not conclusive data but supportive data for further standard test procedure development leading to final NIOSH CBRN SCBA concepts and standards development in the year 2001. At that time contaminating NIOSH-approved SCBA with chemical warfare agent was a novel approach using the newly determined NIOSH concentrations, adapted U.S. Army test procedures and NIOSH HD droplet diagrams. Validation and verification test trials did occur after this benchmark exploratory process was complete resulting in the scientific basis for the existing NIOSH standard test procedures in the NIOSH-Certified SCBA with CBRN protections program.

NOTE 3 : NIOSH benchmark testing to assess respirator fit on human test subjects contaminated with Corn Oil (FDA approved) to determine the NIOSH laboratory respirator protection level (LRPL) for each SCBA was conducted following the live agent benchmarking. Validation and verification LRPL trials did occur prior to a final LRPL STP publication.

Enclosure A-1, GB LAT Observations, October 2001

lT CASARM Nerve Agent (Sarin/GB) at 2000 mg/m3 of vapor x2 (0-30 & 360-390 min). Liquid Aerosol. Matrix Date: 26N 02/03.

ss/Fail Assessment is based on 360min/6hrs. Actual end of test times vary. All data is oral/nasal area using one MINICAM 20psi. Two contamination periods were used. First being at the 0-30 minute mark and a second, if necessary, at the 360-39 ss/fail column is survey data against NIOSH RCT-CBRN-STP-0002, December 14, 2001. All SCBA are 4500psig respirators.

:BA th /linder.	Earliest Failure Time	Cumulative Concentration over Time (Ct)mg-min/m3	Maximum Peaks (mg/m3)	PASS / FAIL	Total Minutes Observed	Applied Post Benchmark Pass/Fail Cr 2.1Ct, mg-min/m3 and 0 .087 mg/m3 2/24/03.
ι	See Notes.	0.54255@363 min	0.04145@75min, 0.01400@111min, 0.00350 @207min	Passed	1131	At the 363 min mark Ct was 0.54255 r then showed steady decrease.
ι	24 min	6.5409@24 min	1.07750 @ 24 min	Failed Ct and max peak value.	180	At 180 min, peak was 0.000295 mg/m
ι	See Notes.	0.02389@360 min	0.00148 @180min, 0.00052 @246min, 0.00038 @276min, 0.00060 @354min & 0.00060 @360min	Passed. See notes.	1362	Military specified combination SCBA-/ MINICAM readings falling below the b caused numerous negative data point the cumulative Ct to go up and down. C2A1 Canister and Camel Bak empty attached and engaged. Camel Bak re: full expansion, despite the fact that it c H2O.
ι	5.5 min	1.1619@9 min	0.19375 @ 9 min	At indicated data rates, this SCBA would have failed.	9	SCBA allowed GB penetration into bre rapid pace causing MINICAM detecto to prevent over saturation.
ι	6.0 min	6.0027@12 min	0.58180 @ 12 min	Failed Ct/peak.	126	2.5Ct at 6.0 minute mark. SCBA was compared to all others that were bran
ι	33-39 min	3.38396@39 min	0.33114 @ 39 min	Failed Ct/peak.	63	Ct was 4.44 at 63 minutes.
ι	6.0 min	3.91343@360 min	0.59114 @ 6 min 0.00033 @ 1182 mn	Failed Ct/peak.	1182	Cumulative Ct only increased 0.34772 during the period of 12 min to 360 min min gave the test a reading of 3.5468 min/m3 Ct.

	25-30 min	8.5278@360 min	1.02005 @ 30 min 0.09881 @ 48 min	Failed Ct/peak.	1212	Cumulative Ct only increased 2.33486 during the period of 30 min to 360 min between 24 to 30 min gave the test a 6.19294 mg-min/m3. Butyl shroud on.
	7-12 min	3.31544@12 min	0.55252 @ 12 min	Failed Ct/peak.	90	Graph extrapolation shows Ct failure a

Publication Administrative Note: There are two versions of the October 2001 LAT data in different software formats. The above Excel file is the master and the following digital scan is a black and white version of the master. Both are available for use, however, the color version is more appropriate and would need to be turned horizontal for publication purposes.

Enclosure A-2, HD LAT Observations, October 2001

NIOSH and US Army SBCCOM Live Agent Test (LAT) Assessment of 9 Traditional SCBAs and Assorted Accessories, 17-31October2001

LAT agent is HD. One exposure of CASARM Distilled Mustard (Blistard),at 300mg/m3 vapor&43 liquid droplets/10ul/droplet(.86ml).Date:26Nov01rev 2002/03.

Pass/Fail Assesment is based on 360min/6hours. Actual end of test times vary. All data is oral/nasal area using one MINICAM detector. Air is120psi.

Pass/fail column is survey data vs NIOSH RCT-CBRN-STP-0002, December 14, 2001 with revisions. All SCBAs are 4500psig working pressure.

SCBA w/Cyl.	Earliest Failure Time	HD Cumulative Ct (mg-min/m3)	Peaks (mg/m3)	PASS / FAIL	Total Min.	Notes:Fail at 0.60Peak & 6.0Ct,TKC, 2/24/2003
1B	See Notes.	0.04954@335 min	0.0018@335 min	Inconclusive. Assessment is this unit may pass but data does not support a conclusion.	335	MINICAM background detection values indicate the first twelve (12) readings being negative, causing 90% of the Ct values to be negative numbers. At the 115 min mark, positive values were detected and resulted in the data indicated. SCBA is NIOSH approved but not NFPA rated.
2B	260 min	8.20598@350 min	0.03156 @ 50 min	Failed Ct	350	No visible destruction. 5.99 Ct at 260min.
3B	See Notes.	0.20056@365 min	0.00069 @ 365 min	Passed	1055	Buytl shroud on. C2A1 & Camel Bak attached.
4B	90 min	11.45109@360 min	0.11498 @ 40 min	Failed Ct	1000	No Butyl Shroud. NFPA rated. No visible effects.
5B	See Notes.	1.12018@30 min	0.105 @ 30min	Initial data supports notes but inaccurate data does not support a conclusion.	110	At 30 minutes Ct was 1.1. It is expected that at 60 minutes the Ct would be 2.2 and increase as time of exposure continued. MINICAMS started generating negative numbers at the 47min mark. This was the only "used" SCBA submitted.
6B	110 min	8.15587@360 min	0.10584 @ 20 min	Failed Ct	1000	Destructive effects on Second Stage Regulator.
7B	See Notes.	0.05015@360 min	0.00559 @ 970 min	Inconclusive data. Possible that more agent permeated than indicated.	970	First eighteen (18) MINICAMS readings are negative, causing 90% of the Cumulative Ct values to be negative numbers. Steady increase noted once MINICAMS started reading positive values.
8B	105 min	13.79097@365 min	0.08045 @ 35 min 0.10729 @ 45 min 0.10984 @ 55 min	Failed Ct	995	Butyl Shroud on. No hydration assembly. Grazing effects on select surfaces. Hard coated lens allowed agent run off. Droplets adhered to shroud.
9B	45 min	4.374379@45 min	0.36370 @ 45 min	Failed Ct	155	Destructive effects on select accessories.

APPENDIX B: Frequently Asked Questions (FAQ)

1. Is it always necessary to perform a "user seal check" on a CBRN SCBA respirator before each use?

Yes. In order to attain the proper designed seal to your face each time you don the facepiece, you should perform the manufacturer suggested user seal check/facepiece fit check. If this is not done every time, you risk entrapping contaminants, breathing contaminants or depleting the air source. Do not confuse a user seal check with a fit test. A user seal check is done by the wearer immediately after donning the SCBA facepiece to ensure a proper seal is attained prior to entering a given workplace requiring respiratory protection. User seal checks, also known as facepiece fit checks, and thus the confusion with the terms fit test, are also done if the user detects facepiece misalignment or cool air as a result of extended wear of the respirator or jarring of the facepiece while being worn. Whereas, a fit test is a qualitative or quantitative respirator performance test done with a selection of respirators on a human subject and by the respirator program administrator or a designated qualified individual. Performing a user seal check before entering a contaminated area is important to minimize contaminant leakage into the facepiece and to minimize leakage out of the facepiece that wastes air and reduces service time. User seal check procedures are located in Appendix B-1 of the OSHA Respiratory Protection Standard [29 CFR 1910.134]. Equally effective manufacturer's user seal check procedures, which are located in the manufacturer's user's instructions specific to the model of respirator, are also acceptable. The OSHA procedures are located at:
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9781

2. How do I tell the difference between a NIOSH-approved CBRN SCBA and a NIOSH-approved SCBA, which is not approved for CBRN protection?

A NIOSH-approved SCBA will only have the NIOSH harness/backframe assembly adhesive label on it for NIOSH industrial compliance. If this same SCBA carries NFPA 1981 voluntary compliance, the NFPA 1981 compliance label from the recognized NFPA laboratory will also be present. With just the two labels, the SCBA is not a CBRN SCBA. CBRN SCBA carry three tiers of approval labels: NIOSH Industrial label, the NFPA compliance label and the NIOSH Special Test Label stating "CBRN Agent Approved" or "CBRN Agent Approved (Retrofit)".

Carefully inspect the SCBA to see if the CBRN Agent Approved label is oni respirator harness assembly. If a respirator is CBRN-approved by NIOSH, it will carry this adhesive label. The label is required to be located on the back frame of the SCBA in a highly visible location. If this CBRN Agent Approved label is **not** on the SCBA, the device is **not** approved by NIOSH for use in CBRN environments. **Check the SCBA for a "CBRN Agent Approved" label!** The label may also contain the word 'Retrofit' denoting that the SCBA was a previously deployed traditional industrial NIOSH approved non-CBRN SCBA which has been upgraded to CBRN protection status.

A new NIOSH logo CBRN Agent Approved label is authorized for use by respirator manufacturers, effective December 5, 2005. The new label indicates only the NIOSH logo and not the CDC logo and NIOSH logo as the old label did. For a period of time there may be CBRN SCBA in the field with both types of NIOSH

CBRN Agent Approved labels. The logo change also applies to the CBRN Agent Approved (Retrofit) adhesive label.

The font size of the NIOSH label may vary between SCBA manufacturers and the exact location of the label on the harness assembly is also at the discretion of the manufacturer.

CBRN SCBA may also have unique markings for specific manufactured production models which are voluntarily designated by the manufacturer. These unique markings, if present, are not required for NIOSH approval, but are provided for the benefit of the user to distinguish CBRN protected SCBA from non-CBRN protected models in the same workplace. Unique markings can consist of color-coded adhesive labels prominently displayed on visible components of the CBRN SCBA, use of the printed letters 'CBRN' to identify second stage regulators, use of the letters 'CBRN' or other equivalent marketing terms, on the side of the backframe, or use of the letters 'CBRN' inside the facepiece or embossed on facepieces.

3. Will a NIOSH-approved SCBA that is not approved with CBRN protection protect me from CBRN agents? Do I have to use a NIOSH-approved CBRN SCBA in a CBRN response?

A NIOSH approved SCBA that is **not** CBRN approved (referred to as an industrial or traditional NIOSH approved SCBA) has not been tested for penetration and permeation resistance to chemical warfare agents as part of its NIOSH approval. Because many chemical warfare agents (CWA) are highly aggressive in terms of their penetration and permeation ability, the traditional industrial or industrial and fire compliant SCBA should not be relied on to provide protection against chemical warfare or terrorism agents. For protection against CWA gas/vapors and liquid contact, a NIOSH-approved CBRN SCBA should be used. The traditional non-CBRN SCBA should be limited to use to for protection against industrial exposures.

The traditional industrial non-CBRN SCBA does provide industrial levels of protection against industrial gases, vapors, and particulate aerosols, including biological (bacteria and viruses), radiological dispersal device, and nuclear fallout particulate aerosols. Additionally, the traditional industrial SCBA provides protection against unknown industrial atmospheres, industrial IDLH or greater than IDLH conditions, and oxygen deficient industrial atmospheres while the fire compliant version provides structural firefighting protection as rated by the NFPA compliance label.

4. Do I need to dispose of my NIOSH approved CBRN SCBA after use/wear time in a known chemical warfare agent (CWA) contaminated environment?

Yes. Following use in an environment with the confirmed presence of chemical warfare agents (CWA) including GB, GA, GD, GF, VX, HD, HN-1, HN-2 and HN-3 and Lewisite in liquid, aerosol or vapor forms, the NIOSH-approved CBRN SCBA must be removed from service and disposed of properly following six **continuous hours** after the initial confirmed exposure. The SCBA should not be reused following this six hour time period and should be decontaminated and disposed of in a manner that is consistent with the type of contamination and any government regulations governing decontamination of contaminated items in effect at the time of response. Some variations on the six-hour use-life rule are possible, at the discretion of the response scene incident commander, but those variations will void the NIOSH-approved CBRN SCBA approval based on what cautions and limitations are not enforced/followed.

After use in an environment that **does not** contain CWAs, the respirator should be cleaned in accordance with recommendations from the manufacturer and current the Centers for Disease Control and Prevention sanitization protocols.

5. How long can I use my NIOSH CBRN SCBA at the scene of a response?

The CBRN SCBA respirator should not be used beyond **six-continuous hours** after an initial confirmed CWA exposure in liquid, vapor or aerosol form to avoid possibility of agent permeation or penetration. Following the six continuous hour time period, the SCBA should be decontaminated and disposed of in a manner that is consistent with the type of contamination and any government regulations governing contaminated items. If CWA are not present, the SCBA should be used in accordance with the manufacturer's user recommendations for inspection, cleaning, and maintenance. If the SCBA was used in a response involving biological or radiological contamination, the SCBA will need to be decontaminated in accordance with manufacturer guidance and recommended CDC decontamination methods before reuse.

6. Where can I find a list of NIOSH approved CBRN SCBA?

A list of currently approved CBRN SCBA is available on the NIOSH, NPPTL web site at:
http://www.cdc.gov/niosh/npptl/topics/respirators/cbrnapproved/scba/

7. Where are the user instructions specific for my CBRN SCBA model?

Every NIOSH approved CBRN SCBA is sold with a printed copy of the manufacturer's user instructions plus a NIOSH CBRN SCBA label insert. If you do not have a printed copy of the manufacturer's user instructions contact the manufacturer or equipment supplier to obtain a current copy. Integration of CBRN related user instructions is at the discretion of the manufacturer. NIOSH is available to assist in locating correct user instructions.

8. What hazards does the CBRN SCBA protect against? Which chemicals and particles, and at what levels?

Note: Read Chapter 2, NIOSH Certification Requirements, for a detailed explanation of protection provided by a NIOSH approved CBRN SCBA.

- *Airborne industrial chemicals*—Chemicals used in industrial applications existing in the airborne states of gases, vapors, and solid and liquid particulate aerosols.
- Specific *chemical warfare agents*—Protection is provided against GB (Sarin), GA (Tabun), GD (Soman), GF (Cyclohexyl Sarin), VX, HD (sulfur mustard), nitrogen mustard (HN-1, HN-2 and HN-3) and/or Lewisite (L, L-1, L-2 and L-3)
- *Particulate aerosols*—Solid or liquid chemicals that are suspended in air. This includes protection against biological aerosols (bacteria and viruses), colloidal suspensions and particulates carrying radioactive isotopes.
- *Unknown atmospheres*—Atmospheres where the types of contaminants and their concentrations are unknown within the limitations of the SCBA.

- *IDLH atmospheres*—Atmospheres where the contaminant concentrations are known to be immediately dangerous to life or health (IDLH) within the limitations of the SCBA.
- *Oxygen deficient atmospheres*—Atmospheres known to contain less than 19.5% oxygen at sea level within the limitations of the SCBA.

10. How do I know if the facepiece is properly sealed to my face so that I am protected?

You know this by conducting a correct user seal check that confirms the air tight seal interface between a correctly fitted and donned respirator and the physical dimensions of your clean shaven face. You should feel a slight vacuum pressure or overpressure when the negative or positive pressure user seal check is done so that no strange odors or sensations are detected while breathing normally with the sealed respirator. With CBRN SCBA, fit testing is routinely performed with special emphasis on maintaining serviceability of unique materials and components that make the SCBA CBRN compliant. This is normally done by adapting the SCBA facepiece to a negative pressure configuration and conducting quantitative fit testing with a calibrated fit test machine. Under OSHA, the respirator program administrator is responsible for managing the workplace respirator protection program and providing fit-tests to respirator users prior to initial use of the respirator, whenever a different respirator facepiece (size, style, model or make) is used, and at least annually thereafter to ensure continued, proper fit [29 CFR 1910.134(f)(2)]. Users should also undergo fit testing when changes in their physical condition could affect respirator fit. Such conditions include, but are not limited to, facial scarring, dental changes, cosmetic surgery, or an obvious change in body weight [29 CFR 1910.134(f)(3)]. The OSHA Respiratory Protection Standard [29 CFR 1910.134] mandates that facepieces, even for positive pressure units, be fit tested in the negative pressure mode. The respirator user should have the option to try different sizes of face pieces (for example: small, medium, & large) while undergoing initial and subsequent fit testing. The manufacturer can provide assistance by providing an adapter to test the SCBA facepiece in the negative pressure mode.

A user seal check is a method for determining whether a respirator has been properly donned (put-on) and properly adjusted to ensure a proper fit. Respirator users should perform a user seal check every time the respirator is donned, before entering a contaminated area, any time the user detects a seal breakage due to work rate and any time the respirator is doffed and re-donned due to hydration or rest cycles. A user seal check evaluates the quality of the seal of the respirator by having the user put the facepiece under positive or negative pressure and noticing leakage. User seal check procedures are located in Appendix B-1 of the OSHA Respiratory Protection Standard [29 CFR 1910.134]. Manufacturer's user seal check procedures, which are located in the manufacturer's user's instructions specific to the model of respirator, are also available and provide unique product insight to the workings of the respirator.

11. What type of training do I need to ensure that I can properly use a NIOSH-approved CBRN SCBA respirator?

- The respirator program administrator is responsible for establishing a training program in compliance with the OSHA Respiratory Protection Standard [29 CFR 1910.134]. Employees should be trained on the following aspects:
- Why the respirator is necessary and how improper fit, usage, or maintenance can compromise the protection of the respirator;

- What the limitations and capabilities of the respirator are;
- How to use the respirator effectively in emergency situations, including situations in which the respirator malfunctions;
- How to inspect, put on and remove, use, and check the seals of the respirator;
- How to recognize medical signs and symptoms that may limit or prevent the effective use of respirators
- Unique CBRN SCBA user's instructions and locations of CBRN NIOSH label confirming CBRN approval of the CBRN SCBA or upgraded SCBA to CBRN protection.

11. Is it necessary to wear a protective suit ensemble or protective clothing in conjunction with a CBRN SCBA?

Most CBRN contaminants produce toxic effects when in contact with the skin. Proper and expedient decontamination of the CBRN contaminants can and should limit the long term efficacy of those agents. The effects from CBRN agents can be immediate, masked, or delayed, depending on the type of contaminant, concentration, and dissemination conditions.

NIOSH has issued Caution and Limitation 'Q' for the CBRN SCBA which states: **"Q Use in conjunction with personal protective ensembles that provide appropriate levels of protection against dermal hazards."**

CBRN SCBA are approved by NIOSH as stand alone respiratory protection devices and not in tandem with a protective suit ensemble or other type of protective clothing. The 'Q' caution and limitation statement advises users that an appropriate level of protective clothing should be worn with the CBRN SCBA.

CBRN SCBA are designed by manufacturers to be compatible or for use with various levels of protective clothing, to include encapsulating suits (those which completely enclose the wearer's entire SCBA) and non-encapsulating protective suits (suits which partially enclose or cover the SCBA).

The type of protective clothing or protective suit ensemble used must be based on dermal protection needed for the identified type of CBRN hazard. The user must be outfitted with an appropriate protective ensemble or protective suit to protect against skin absorption. The selection of the protective ensembles must relate to recognized definitions of the types of ensembles that can be used for CBRN incidents.

It is not the intention to use the NIOSH-approved CBRN SCBA for multiple incidents lasting longer than six hours of continuous contamination, however; it may be possible to reenter specific CBRN incidents within a given six hour timeframe, following a quick gross decontamination/ladder truck decontamination and replenishment of an air supply within the six hour timeframe of the CRUL for the CBRN SCBA hardware.

If the protective suit is compromised through fair-wear-and tear or the collateral effects of a secondary CBRN agent dissemination device and a non-CBRN approved SCBA is worn instead of a CBRN SCBA, the interior of the suit may become a temporary confined space and contribute to CBRN agents contaminating the dermal areas and respiratory system of the user simultaneously.

Since the predominate route of entry for chemical warfare agents is the respiratory system, wearing a NIOSH-approved CBRN SCBA provides a greater level of respiratory protection than a traditional NIOSH-approved non-CBRN SCBA in this example of a compromised Level A or B ensemble. Adequate protection provided by a NIOSH approved CBRN SCBA will ensure minimum respiratory protection is provided, even if the suit

is compromised. This respirator protective quality may offer just enough time for the wearer to escape contamination and go to a less contaminated area for immediate decontamination and live saving measures. A properly maintained and donned NIOSH-approved CBRN SCBA provides the highest level of respiratory protection available to Level A or Level B outfitted emergency responders and other relevant workers.

12. Will wearing a protective suit ensemble protect my CBRN SCBA from becoming contaminated?

Only protective clothing ensembles designed to completely enclose an SCBA within an encapsulating suit or non-encapsulating suit, suits which enclose but are not vapor tight, will provide a level of protection for the SCBA hardware to prevent or reduce SCBA contamination. Protective clothing ensembles that expose the CBRN SCBA visor and second stage regulator to ambient toxic concentrations should be limited to vapor exposures, if possible. It is expected that CBRN liquid agents will attack any open crevice between the respirator facepiece and the protective ensemble hood or collar. If known CBRN liquid exposures are expected or determined, emergency responders should require full Level A encapsulated ensembles to protect the entire responder and SCBA. The next generation of improved Level A ensembles or variations of that ensemble are incorporating unique suit interfaces that bridge the gap between the respirator and the suit hood interface---That same area that is now covered by adhesive non-regulated chemical tape (Chem Tape). Next generation NFPA protective suite compliance standards do not support the use of chemical tape for NFPA compliance certification purposes. (Chem Tape is industrial hazardous material specific adhesive tape that is designed by material manufacturers to be chemically resistant to select toxic industrial chemicals and third party concentrations of chemical warfare agents.)

EPA developed Level A and B personal protection levels utilize SCBA and specific protective suit ensembles, with accessories.

EPA Level A suit ensembles are vapor, aerosol, solid, liquid, and gaseous protective against known specific industrial agents. NIOSH CBRN approvals do not exist for EPA Level A, B, C or D protective suit ensembles.

NFPA compliance testing of given protective ensembles is underway and expected to provide a level of chemical warfare agent protection under a given laboratory condition.

EPA Level B suit ensembles are liquid-tight and provide protection from liquid splashes but do not protect against chemical vapors or gases.

NIOSH recognizes that the protection provided by a Level A or Level B encapsulated suit will likely prevent CBRN contamination from contacting a NIOSH CBRN SCBA depending on the physical state of the CWA (liquid or gas/vapor state) and the corresponding Level A or B suit, but currently does not issue approvals to that effect.

In these instances where the appropriate level of encapsulated suit is used corresponding to the physical state of the CWA, the limitation of six continuous hours of use from the time of initial chemical warfare agent (CWA) exposure would not apply until the suit is compromised or the CBRN SCBA is inadvertently or deliberately exposed to CWA contamination as a result of doffing, normal wear-and-tear or direct or collateral physical or puncture damage.

For Level B ensembles which are non-encapsulating, the CBRN SCBA head harness must be on the inside of the suit ensemble hood and not be directly exposed to ambient hazards. If the head harness is worn over the protective hood, the fit test sealing properties will most likely not be replicated by the intended design or the

facepiece will have to be tightened excessively to obtain a proper seal and cause adverse pressure headaches on the user.

While the process of wearing the respirator head harness overtop/outside the protective hood may appear to solve the suit to respirator interface gap, this donning style does not allow the suit to fully protect the head area by wicking away liquid contamination and may/most likely compromise the sealing properties of the respirator face-to-facepiece seal. Those SCBA components exposed to the environment, such as the lens of the facepiece, should be considered contaminated, if used in a CWA agent environment, and for those components and the entire CBRN SCBA, the six hour use limitation does apply.

In the case of protection against chemical warfare agents, not all chemical protective suits are tested and provide the same level of protection against chemical warfare agents. A suit ensemble which has been tested to a proven recognized third party protection standard against CWA or next generation recognized CWA simulants, must be used if CWA protection is sought for emergency response use.

13. How do I determine that my 'Non-CBRN' NIOSH-approved SCBA can be upgraded to NIOSH-approved CBRN protection (upgraded is also known as retrofitted)?

Please contact the respirator manufacturer first. Then visit the NIOSH/NPPTL website to locate the model of SCBA in use and whether it has a NIOSH approved CBRN Upgrade/Retrofit Kit available.

Select SCBA models of previously deployed traditional 'non-CBRN' NIOSH-approved SCBA can be upgraded for protection against CBRN agents, using procedures and materials designated by NIOSH and implemented by the respirator manufacturer.

The best source of help for this question is to contact the respirator manufacturer of the current deployed traditional industrial or fire compliant SCBA respirator to determine if the respirator is capable of being upgraded or retrofitted to CBRN protection. A manufacturer's representative may need to physically inspect the unit to determine if it is a model that is capable of being upgraded to CBRN protection status. NOT all models are capable of being upgraded. As stated, please consult with the respirator manufacturer first. Currently, only NFPA standard 1981, editions 1997 and 2002, have NIOSH approved CBRN SCBA upgrade kits approved and in production. Next editions of the NFPA 1981 standard, such as the pending 2007 edition, may require new or additional labels for NFPA CBRN compliance. In addition to contacting the respirator manufacturer, please contact the NFPA for the most current information related to implementation of the voluntary NFPA compliance standard.

The NIOSH-approved CBRN SCBA upgrade/retrofit procedure involves the respirator manufacturer demonstrating eight administrative/testing actions: accurate configuration management, identification of field deployed SCBA that are eligible for upgrade, installation of specific new CBRN approved parts, inspection of the retrofitted SCBA, submission to NIOSH for CBRN testing, re-installation of defective components found during NIOSH inspection or testing, resubmission, as necessary, to NIOSH of re-tooled defective configurations and adding new CBRN retrofit adhesive labels and user instructions.

A NIOSH-approved CBRN SCBA upgrade approval signifies that the products receiving the upgrade are expected to protect firefighters and other emergency responders from CBRN-related gaseous, airborne particulate, and liquid respiratory exposures, despite the number of use hours already logged on the respirator as a system. NIOSH based its retrofit approval program on the determination of rigorous laboratory tests,

evaluation of product specifications for the upgrade procedures and materials, and an assessment of the manufacturer's quality control procedures.

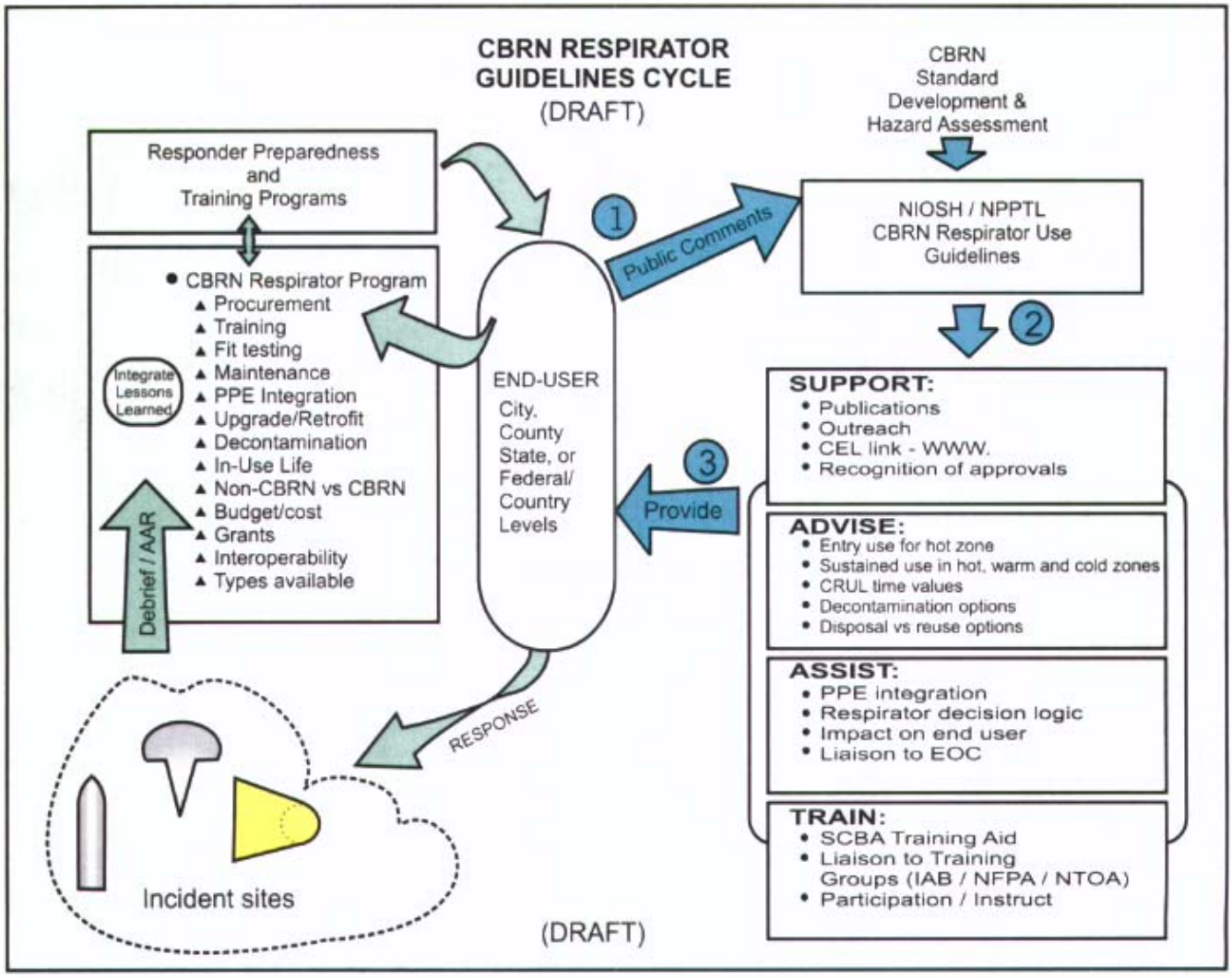
A bill of materials, identifying the various models of SCBA eligible for CBRN SCBA upgrades and parts required for retrofitting, is available from the manufacturer.

NIOSH-approved CBRN SCBA upgrades of a field deployed SCBA should not be done by untrained or unauthorized personnel. Contact the SCBA manufacturer for specific CBRN SCBA upgrade programs available. New NIOSH-approved SCBA are not retrofitted SCBA to CBRN protection. They are distinct from field deployed retrofitted NIOSH-approved SCBA in various manners but the primary manner is that new NIOSH-approved SCBA are not considered 'used'/field deployed SCBA are will not show the degree of fair-wear-and-tear that a retrofitted SCBA original hardware may show.

APPENDIX C: User Training Checklist

1. Are NIOSH-approved CBRN SCBA available for all first responders and leaders of departments?
2. Are the SCBA new or used? If new, and the SCBA are expected to be NIOSH-approved CBRN SCBA, do they carry the NIOSH 'CBRN Agent Approved' label? If not, they are not CBRN SCBA. Perhaps, they need upgraded? Is a CBRN SCBA upgrade kit in use? Can you recognize an upgraded SCBA from a new CBRN SCBA? Are CBRN Agent Approved Retrofit adhesive labels located on the harness assembly?
3. If CBRN SCBA are not available, have the available SCBA been tested by a third party for determination of resistance to liquid or vapor chemical warfare agent?
4. Are NIOSH-approved CBRN SCBA available from mutual aid departments?
5. Do responders have basic and advanced WMD awareness training prior to entering an unknown situation with SCBA or CBRN SCBA?
6. Are the drivers of incoming responder vehicles trained to drive with CBRN SCBA donned?
7. Are driver cabs of emergency vehicles over-pressurized or air tight sealed with filtration to maintain a level of protection to passengers who have not donned CBRN SCBA?
8. If you have just purchased new or upgraded CBRN SCBA, do you have complete confidence that all unique CBRN protection characteristics of the SCBA have been explained and understood?
9. Are emergency and deliberate entry SOPs updated to include the use of CBRN SCBA?
10. Are provisions in place to supply CBRN approved respirators to initial and triaged casualties?
11. Are available Level A protective ensemble pass thru devices compatible with CBRN SCBA?
12. Does local SOP or SOG emphasizes proper respirator fit testing, head harness worn over head instead of outside on hood of ensemble/suit, and CBRN SCBA use life (CRUL)?
13. Who is the CBRN SCBA hydrostatic tester?
14. Is the CBRN SCBA fully assembled?
15. Is the CBRN SCBA fully operational?
16. Does the CBRN SCBA show the correct NIOSH CBRN label confirming the system is CBRN approved?
17. Do the part numbers listed on the NIOSH CBRN label insert located in the user's instructions, match the part numbers visible on the CBRN SCBA?
18. Are all manufacturer unique CBRN markings readily known by the wearer?
19. Are all readiness before use operations checks complete?
20. Are CBRN SCBA decontamination plans in place?
21. Are CBRN SCBA disposal plans in place?
22. Are CBRN SCBA replacement parts and systems in place?
23. Are compressed air cylinders full and in ample supply for change out Are universal cylinders in use?
24. Is an established CBRN SCBA use life protocol available and capable of being implemented?
25. Are compatible protective ensembles available to provide dermal protection?
26. Are proper handling techniques established and rehearsed for handling contaminated CBRN SCBA after each use or between multiple entries during the same use?
27. Are decontamination and disposal procedures followed as required? Are manufacturers consulted on recommended decontamination procedures?
28. If liquid CBRN agents contaminate the CBRN SCBA, are disposal actions in place?
29. Is the respirator used beyond six-hours after initial exposure to chemical warfare agents?

APPENDIX D: CBRN Respirator Guidelines Production Cycle



The CBRN respirator guidelines cycle describes the cyclic integration of end-user information to the NIOSH-NPPTL CBRN respirator use guideline publication process-1. NPPTL supports responders with publications, outreach education briefings, internet interactive pages to certified equipment links, and letters of approval. NPPTL also advises, assists, and trains users as necessary- 2. NPPTL provides publications and participates in local emergency responder exercises by observing training and integrating learned outcomes to make better user guidance documents-3. End-users in turn, conduct real time responses, train for real time responses, and continually integrate lessons learned during event debriefs and after action reports. Responder preparedness levels increase as the cycle rotates and interacts at each level.

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